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VOL. CXXXIII.—No. 3455] LONDON: FRIDAY EVENING, MARCH 17, 1922 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of—
CABLE, ELECTRIC.
PIPES, CAST IRON.
Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 31st March, 1922.
T. RYAN,
Director-General.
7697

Assistant Engineer Required by the GOVERNMENT of NIGERIA for the Public Works Department for two tours of from 12 to 18 months' service, with possible extension. Salary £480 per annum, rising by annual increments of £30 to £720 per annum and thence by annual increments of £40 to £920 per annum. Outfit allowance of £60 paid on first appointment. Free first-class passages and single quarters provided. Liberal leave in England on full salary after each tour.
Candidates, age between 25 and 35, preferably single, must have had good practical experience as civil engineers upon public works, buildings and roadmaking, and preferably should be A.M.I.C.E.
Apply at once, in writing, giving age and brief details of experience, to CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/Nigeria 11,316. 7718

Belfast Harbour.
The Belfast Harbour Commissioners are prepared to receive TENDERS for the CONSTRUCTION of a JETTY and DOLPHINS in REINFORCED CONCRETE on the eastward side of the New Oil Berth, Musgrave Channel, Co. Down, all in accordance with drawings, which may be seen at the office of the Harbour Engineer, Mr. T. S. Gilbert, M. Inst. C.E., from whom copies of the conditions of contract, draft specification, and form of Tender may be obtained.
Tenders must be made on the form provided for the purpose and must be enclosed in a sealed envelope, endorsed "Tender for Jetty and Dolphins," addressed to the General Manager and Secretary, Belfast Harbour Commissioners, and delivered to him not later than Monday, the 3rd April, 1922.
The Commissioners do not bind themselves to accept the lowest or any Tender.
D. J. OWEN,
General Manager and Secretary.
Harbour Office, Belfast,
11th March, 1922. 7669

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Wednesday, 5th April, TENDERS for the SUPPLY of :
1. CRANK and STRAIGHT AXLES for LOCOS.
2. COPPER FIRE-BOX PLATES.
3. HELICAL and VOLUTE SPRINGS.
4. LAMINATED SPRINGS.
5. STEEL BOILER TUBES.
6. TYRES for LOCOMOTIVES.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices: The White House,
91, Petty France,
Westminster, S.W. 1.
13.3.22. 7683

City of Leicester.
WATER DEPARTMENT.
PUMPING MACHINERY.
The Water Committee of the City of Leicester invite TENDERS for the SUPPLY and ERECTION of OIL or GAS ENGINES and PUMPS for pumping continuously 50,000 gallons of water per hour through about 70,000ft. of 14in. diameter pipes against a static head of 122ft.
General conditions, specification, and form of Tender may be obtained from C. T. Edwards, Esq., M. Inst. C.E., Water Engineer and Manager, Bowling Green-street, Leicester, on deposit of a cheque value Five Pounds, which will be returned on receipt of a bona fide Tender and the return of all documents supplied.
Tenders, endorsed "Pumping Machinery," are to be delivered to the undersigned in a sealed envelope on or before 10 a.m. on April 10th next.
The Committee do not bind themselves to accept the lowest or any Tender.
G. T. EDWARDS, M. Inst. C.E.,
Engineer and Manager.
Waterworks Office,
Bowling Green-street, Leicester. 7665

Department of State Railways.
NOTICE.
TENDERS are INVITED for the SUPPLY of 25 UNDERFRAMES for BOGIE CARRIAGES.
Specifications and drawings may be obtained against payment of £2 from Messrs. C. P. Sandberg, 40, Grosvenor-gardens, London, S.W. 1.
Sealed Tenders, with the inscription "Tender for the Supply of Underframes for Bogie Carriages, 2445," must be forwarded to the undersigned, at whose office in the city of Bangkok, Siam, they will be received up to 3 p.m. on the 1st day of August, 1922, at which place and hour the Tenders will be publicly opened and read.
Right is reserved to reject any or all Tenders and to accept any Tender which in the opinion of the undersigned is to the best interests of the Siam State Railways.
GENERAL PURACHATRA,
Commissioner-General of State Railways,
Department of State Railways, Bangkok,
3rd February, 1922. 7673

East Indian Railway.
The East Indian Railway Company is prepared to receive TENDERS for the SUPPLY and DELIVERY of :—
(1) GALVANISED CORRUGATED SHEETS,
(2) OPEN and COVERED GOODS WAGONS,
(3) WHEELS and AXLES,
(4) WHEEL LATHES,
as per specifications to be seen at the Company's offices.
Tenders are to be sent to the undersigned not later than Eleven o'clock a.m., marked "Tender for Galvanised Sheets," or as the case may be, for No. on Wednesday, the 29th day of March instant, and for Nos. 2, 3, and 4 on Wednesday, the 5th day of April proximo.
The Company reserves to itself the right to divide the order, also to decline any Tender without assigning a reason, and does not bind itself to accept the lowest or any Tender.
For each specification a fee of £1 1s. is charged, which cannot under any circumstances be returned.
By Order,
G. E. LILLIE,
Secretary.
Nicholas-lane, London, E.C. 4,
15th March, 1922. 7705

The Engineer

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PUBLIC NOTICES

All Interested in Belgian ENGINEERING SPECIALITIES and CONTINENTAL MANUFACTURES are INVITED to VISIT the BRUSSELS INTERNATIONAL COMMERCIAL FAIR, held from 3rd to 19th APRIL.
Buyers' cards and information regarding lodgings free on application.
19, Grand' Place, Brussels. 7598

Parish of Lambeth.
BOARD OF GUARDIANS.
ELECTRIC LIFT.
The Guardians of the Poor of the Parish of Lambeth hereby invite TENDERS for the SUPPLY and INSTALLATION of an ELECTRIC LIFT and the DISMANTLING and REMOVAL of an existing LIFT at their Infirmary, Brook-street, Kennington, S.E.
Tenders, which must be endorsed "Tender for Lift," must be sent to the undersigned or placed in the box provided for their reception in the office of the Clerk to the Guardians, by the tenderers or their representatives, should they so desire, on or before Tuesday, the 28th March, 1922, and will be opened in the Board Room at noon on the following day, when all persons tendering or their authorised agents should be in attendance. Specification and form of Tender may be obtained from the undersigned.
The Guardians do not pledge themselves to accept the lowest or any Tender.
By Order of the Guardians,
JAMES L. GOLDSPINK,
Clerk.
Guardians' Offices,
Brook-street, Kennington-road, S.E.,
13th March, 1922. 7681

Swansea Harbour Trust.
The Swansea Harbour Trustees invite TENDERS for the REPAIR of certain FERRO-CONCRETE QUAYS in their King's Dock, by means of the Cement Gun. The quays may be inspected, and further particulars of the nature of the repairs to be executed may be obtained on application to the Trustees' Engineer, Mr. A. O. Schenk, M.I.C.E., Harbour Offices, Swansea.
Tenders, marked "Repairs to Quays," should be delivered to the undersigned not later than 10 a.m. on Friday, the 24th March, 1922.
The Trustees do not bind themselves to accept the lowest or any Tender.
TALFOURD STRICK,
Clerk.
Harbour Offices, Swansea,
25th February, 1922. 7544

The Madras and Southern MAHRATTA RAILWAY COMPANY, LIMITED.
The Directors are prepared to receive TENDERS for :
(1) 10,910 PICKS, SHOVELS and FIREWRAHS,
(2) 118 TONS RED and WHITE LEAD,
(3) 22,320 LINEAL YARDS CANVAS and BUNTING,
(4) 217 TONS SPRING STEEL,
(5) 22,384 FILES,
(6) 60 TONS METALS (Zinc, Aluminium, Antimony, Brass, Copper, Lead and Nickel),
in accordance with the specifications, which may be seen at the offices of the Company. The charge for each specification is One Guinea, which will not be returned.
Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, the 4th April, 1922, marked "Tender for Picks, Shovels, &c.," or as the case may be.
The Directors do not bind themselves to accept the lowest or any Tender.
Company's Offices,
25, Buckingham Palace-road,
Westminster, S.W. 1,
14th March, 1922. 7715

PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
MARINE BOILERS.
The Proprietor of British Patent No. 143,892 is PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to single-ended return-tube marine boilers having water tubes at the rear communicating with transversely arranged upper and lower drums.
Address: B. W. and T.,
111/112, Hatton-garden,
7660 London, E.C. 1.

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
RAILWAY TRACK BEDS.
The Proprietor of British Letters Patent No. 140,116 is PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to means for reinforcing track beds at the rail joints. Reinforced concrete grates are embedded in the ballast.
Address: B. W. and T.,
111/112, Hatton-garden,
7671 London, E.C. 1.

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
STEAM TURBINES.
The Proprietors of British Letters Patent 117,705 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It comprises improvements in the construction and arrangement of the stator and rotor buckets in circular-flow type turbines.
Address: B. W. and T.,
7688 111/112, Hatton-garden, E.C. 1.

The Great Indian Peninsula RAILWAY COMPANY.
The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

No.		Fee for Specification.
1	STEEL WORK FOR BRIDGES	£1

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.
The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.
Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Steel Work for Bridges," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 28th March, 1922.
The Directors do not bind themselves to accept the lowest or any Tender.
E. H. WALPOLE,
Secretary.
Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 15th March, 1922. 7704

The Swanage U.D. Council have FOR DISPOSAL the following SURPLUS PLANT :—
12 B.H.P. PORTABLE ENGINE, by Sykes and Co., No. 1254.
1 STEAM WINCH.
1 Medium-lift WORTHINGTON PUMP, 10 by 10 by 10, No. 79,249.
1 High-lift WORTHINGTON PUMP, 12 by 5 by 12.
1 4 H.P. TANGYE OIL ENGINE.
2 400-Gallon TANKS.
1 WELL PUMP and RODS.
1 GALVANISED IRON SHED as erected.
1 SECTIONAL ARMY HUT, 60 by 15.
2750 FEET of 8in. STEEL MAIN.
3520 FEET of 6in. CAST IRON MAIN.
For further particulars apply,
F. B. GOODMAN, M.I.M. and Cy. E.,
7662 Engineer to the above Council.

PUBLIC NOTICES

British North Borneo.
REQUIRED IMMEDIATELY, in the PUBLIC WORKS DEPARTMENT of NORTH BORNEO, TWO ENGINEERS.
Candidates should be single and under 30 years of age; active, of good physique, with thorough knowledge of instrument work and well trained in ordinary engineering knowledge; must have been trained in a recognised engineering college and should have passed A.M.I.C.E. exam. or hold exempting degree; should have had good practical experience on public works. Preference for one appointment will be given to candidate with waterworks experience.
Salary £490, rising annually by £21, with house or house allowance and duty allowance of £58. Five years' agreement, with first-class free passage out and home on completion of agreement. Appointment subject to medical examination.
Apply (in writing) not later than 3rd April, with full record of career in chronological order, giving age and details of general and technical education, training and subsequent experience, testimonials (copies only), service certificates, &c., to Messrs. RENDEL, PALMER and TRITTON, 12-14, Dartmouth-street, S.W. 1. 7682

Brownhills Urban District COUNCIL.
APPOINTMENT OF ENGINEER AND SURVEYOR.
The Urban District Council of Brownhills (Staffs) invite APPLICATIONS for the OFFICE of ENGINEER and SURVEYOR.
Preference will be given to candidates who have qualified as members of either the Institution of Civil Engineers or the Institution of Municipal and County Engineers.
The person appointed will be required to carry out the various duties imposed upon him by the Public Health Acts and other general statutes and such other duties as may be determined by the Council.
He will be provided with offices and assistance and will be required to devote his whole time and attention to the duties of the office and not to engage in private work or other business, and to give approved security and reside in the district.
The engagement will be during the pleasure of the Council and capable of termination by three months' notice on either side. Applications, stating age, salary required, qualifications and experiences, accompanied by copies of not more than three recent testimonials, must be sent to the undersigned not later than 5th April, 1922.
Canvassing, directly or indirectly, will be a disqualification.
W. FRED. HALL,
Clerk to the Council.
21, Park-street, Walsall,
8th March, 1922. 7697

SITUATIONS OPEN

THE STANTON IRONWORKS COMPANY, Ltd., near Nottingham, hereby announce that they have now FILLED the APPOINTMENT of WORKS MANAGER for their Reinforced Concrete Works, and would be glad if all applicants would take this as an official notification. P5140 A

WANTED in a Municipal Engineer's Office in the North of England, a young MECHANICAL ENGINEER with good theoretical and practical experience. A knowledge of the handling of men and materials would be an advantage.—State age, full particulars of experience, and salary to Box 935, c/o Judd's, 97, Gresham-street, London, E.C. 2. 7546 A

WANTED, SALESMAN, with Connection, Capable of handling Steam Specialities, Feed Pumps, &c. Salary and previous experience.—Address, 7613, The Engineer Office. 7613 A

ASSISTANT WORKS MANAGER, with Experience in that capacity in light engineering works. Must have thorough technical knowledge and organising ability.—Address, stating age, experience, and salary required, 7717, The Engineer Office. 7717 A

ANTI-FRICTION METALS AND TYPE METALS.—EXPERT ADVICE REQUIRED in the Manufacture of the above. Only replies from practical persons considered.—Address, 7695, The Engineer Office. 7695 A

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MAINTENANCE ENGINEER (Working) for Glass Works near London. Should have experience of Compressors, Boilers, A.C. Motors and General Millwrighting.—Address, stating age, experience, and salary required, P5115, The Engineer Office. P5115 A

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Also ONE DITTO for Notts, Derbyshire, and South Yorkshire.—Address, P5131, The Engineer Office. P5131 A

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WORKS MANAGER for Light Engineering Works REQUIRED, with wide mechanical and administrative experience. Only those who have already held similar post need apply.—Address, stating age, qualifications, experience, and salary required, 7716, The Engineer Office. 7716 A

WANTED for Constructional Engineering and Boiler Works, FOREMAN over Smiths and Welders; experience in Hydraulic Presswork, Oxy-acetylene and Electric Welding Process essential.—Write, giving qualifications, age, salary, and when at liberty to the Secretary, CLAYTON, SON and CO., Ltd., Moor End Works, Hunslet, Leeds. 7662 A

WANTED, WORKS FOREMAN for Constructional Steel Works near London; 5 o'clock man, good knowledge of up-to-date economical methods of Structural Steel Work Manufacture essential.—Address, stating age and previous experience, P5125, The Engineer Office. P5125 A

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ENGINEER (40), First-class Experience in Machine fitting and erecting shops, motor cars and general engineering, 11 years as general foreman, energetic and good organiser, DESIRES similar POST of responsibility and trust.—A. H., 24, Boschurch-road, West Ealing, London. P5139 B

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For continuation of Small Advertisements see page iii

Our Mineral Statistics.

In accordance with established procedure we give herewith a review of Part III., "Output," of the Mines and Quarries General Report and Statistics for 1920. This is the first report signed by Mr. T. H. Mottram, who last year succeeded Mr. William Walker, whose tenure of the office of Chief Inspector of Mines was but a brief one. It is also the first report addressed to the Secretary for Mines instead of to the Secretary of State for the Home Department. Whether or no the next one will be addressed to the President of the Board of Trade is a matter on which we will not speculate. Although the report is again of the attenuated form of the war and following years, it has taken on a somewhat different appearance, and as there are no apologies for the reduced size, and, we may add, considerably decreased cost, it appears that the economy of information and also of cost of production is intended to be permanent. Whether this be so or not, those in possession of pre-war reports with their references to the outputs of individual mines, the informative tables of imports and exports, &c. &c., will no doubt treasure them up as works of reference which may come in useful.

Having said so much, we hasten to add that the report is by no means of the stereotyped form which has done duty for so many years. The few general remarks which the limited space available permits of with regard to specific ores have been re-written, and the publication generally strikes us as less of a mere compilation of statistics and more as the work of one with an interest in his subject and, if we may say so, with a somewhat closer knowledge of its wide ramifications.

Output Data.

Statistics of all sorts during recent years have dealt almost entirely with values which, relating to boom prices, have afforded no guide to work preformed. In the present document an informative summary table compares the output and price of the minerals in 1920 with the corresponding figures for 1913. Including coal, which is, of course, by far the most important mineral we produce, the 1920 tonnage is valued at 427 millions, though on the basis of prices ruling in 1913 the figure would be 127 millions sterling. This figure of 427 odd millions is nearly 92 millions in excess of 1919, owing largely to the inflation of selling values. Although the present slump commenced in 1920, its effect is hardly apparent in this report, and it remains for the next one to indicate the great change that has come about. Generally speaking, it appears that the output of mineral, excluding some from shallow workings, was about one-fifth less in 1920 than in 1913, though the number of persons employed had increased by 8 per cent. In a previous review we made special reference to the precarious state of our non-ferrous metalliferous mining, owing to the great increase in working costs, notably for labour. The effects are seen in the present report, and will be much more pronounced in that for 1921 when so many lead and zinc mines closed down.

Compared with 1913, our output of lead ore had fallen by two-fifths, tin ore by 40 per cent., and zinc ore by 70 per cent., while dressed copper ore had fallen from 2569 tons to 81 tons. We may say, however, that we view the future with more equanimity than when we were writing last year, because in addition to the falls which have occurred in the price of mining materials, the attitude of labour has undergone a change, and although some abandoned mines are unlikely to be reopened, there are others which will undoubtedly be got going again at lower costs of production. Of course, as in the past, the market price for the metals will remain a factor of the greatest importance, but that is a matter in which the co-operation of labour might be made effective on some sort of a profit-sharing basis where low wages in bad times were succeeded by higher in good times. Something of the sort is already to be seen in the working of the reopened lead mines on the Wraith rake near Winster, Derbyshire, by the disaffected miners from Mill Close.

Prices and Assays.

Great fluctuations occurred in 1920 in the price of copper, lead, tin, and zinc, the prices falling in December to about half what they were in February. Attempts to obtain Government aid proved abortive, and so, as we have already hinted, the returns for non-metalliferous mining for 1921 will prove melancholy reading, and this despite the fact that prices for the various concentrates compared very favourably with those obtained in 1913. In the table on page 90, showing the average selling value of certain dressed ores at the mines, 32.7 per cent. is given for the zinc assay. This is the average figure, including such mines as Nenthead, Halkyn and Great Laxey, which figure as the principal producers.

Although it is notorious that most work to-day is not up to pre-war standard, it is difficult to imagine that mines which used to dress up to about 50 per cent. zinc can have turned out concentrates of much lower grade, and if this surmise be correct some of the other producers must have sold concentrates of far below 30 per cent. assay, which, on the face of it, is somewhat inexplicable, that is, having regard to pre-war practice and conditions. To carry this topic a stage further, in Table 88 the output of zinc ore from Dumfries, Kirkcudbright, and Wicklow is for some reason lumped together as 1428 tons, and the amount of zinc obtainable by smelting is given as 322 tons. Roughly speaking, this would represent a 28 per cent. ore, and as the usual figure for the Wanlockhead mine, Dumfriesshire, used to be 47 per cent., it follows that the ore sent away from Kirkcudbrightshire—presumably from the Wood of Cree mine near Newton Stewart—must have been of very low grade. We have referred to this matter of percentages of metal because, although an average figure may be useful for purely statistical purposes, it is apt to give a very wrong impression of the capabilities of our mining engineers and mining plant to the casual seeker for technical information. With regard to lead ore, the average assay is given as 71.2 per cent. metal, which is about 10 per cent. lower than the usual figure for concentrates at the principal mines outside Derbyshire, and must, therefore, include some low-grade ore.

The Mines Department.

Turning to a more general topic, it is clear from the wording in the report of the Geddes Committee that mines mean coal mines and nothing else. It may be quite true that since the Mines Department was formed the circumstances have completely changed, and that the mines have been returned to the owners. The word coal is not mentioned, but it is clear that coal and nothing else appears to have been considered. Certainly, the Department has only with some difficulty been brought to see the advisability of taking something more than a passing or lukewarm interest in our metal mines, and the hopes of those whose interests are concerned with metalliferous mining as to the benefits to be expected from the founding of the Department have had severe knocks. In the circumstances, therefore, the passing of the Department, if it comes about, will occasion few tears in non-coal-mining circles.

Coal.

The output of coal, including anthracite, was 229,532,081 tons, practically the same figure as in the preceding year. It will be remembered that Government control existed the whole of the year, and that the majority of the pits were idle for two or three weeks during October and November in consequence of the strike. As it has not been customary in the past to give any details with regard to the purity of coal, we have no information on that head on which to comment in the 1920 output, which certainly included far more dirt than was customary in pre-war days. Whether we shall ever get back to the old standard of purity is a matter for speculation. In times of shortage the purchaser is disinclined to invoke the aid of the Sale of Goods Act and insist on being supplied with the particular goods demanded, and there has been singularly little in the way of complaint under what may fairly be described as extreme provocation. Of course, in the minds of possible litigants there was always the spectre of the Coal Controller representing the Government in the background.

One important action, however, came into Court with regard to the supply of bunker coal, which the Assize Judge held was not of the nature and quality demanded and had been sold without the exercise of due care and judgment as enjoined in the Sale of Goods Act. The defendant pleaded that he was powerless in the hands of the Coal Controller, but the Judge brushed that contention aside. This decision was reversed by the Court of Appeal, and the case is now to come before the House of Lords. One other matter with regard to modern coal may be referred to, and that is the frequent presence of solid pyrites in house coal due to inefficient screening. This is not merely an annoyance, but a positive danger, as from our own investigation we have little doubt that in the cases of deaths of children by reason of their clothing being ignited by "a cinder which flew out of the fire," the projectile was a lump of iron pyrites. This would certainly seem a matter which requires attention from some authority, as it transcends the mere annoyance of having shale supplied with household coal.

Coke.

About 37 million tons of coal were used in the production of coke at gasworks and coke-oven plants, practically the same figure as in 1913. The former preponderance of the beehive oven grows smaller as time goes on, though its decline is not at the rate which many people would like it to be. About 12¼ million tons of coal were carbonised in coke-oven plants both in 1913 and 1920, and it is interesting to note that out of a total of 15,400 ovens in use in 1920, 5384 were beehive and the rest consisted of proprietary ovens recovering by-products, the most prominent among them being the Simon-Carves, Otto-Hilgenstock, Semet-Solvay, and Koppers. In 1913, there were 21,006 ovens in use, 13,167 being of the beehive type. The somewhat lengthy statistical tables showing the tonnage of coal and coke carried by the various systems of railway, canal, and other inland navigation companies are omitted from the report for the first time.

Arsenic and Barytes.

To refer now to some of the more important and interesting minerals in alphabetical order, we note that arsenic, i.e., crude arsenious acid, amounted to 1997 tons against 2527 tons in the previous year, while arsenical pyrites rose from 75 tons in 1919 to 1178 tons, indicating that all in recent Cornish mining is not black and depressing. The output of barytes was 60,277 tons against 55,522 tons in 1919, the value remaining about the same. Sixteen counties had returns, Shropshire being at the head of the list, the principal other counties in order of merit being Durham, Derby, Cumberland, York, Ayr, Cork, Westmorland, and Montgomery, which shows the wide distribution of workable deposits. Although some of the Cumberland output is witherite, the carbonate, the rest of the production of the above counties and others not mentioned is the sulphate. Northumberland produced 3585 tons of witherite, about the same figure as in the preceding year, although a few years back the out-turn rose to about double the amount. In Derbyshire, the bulk of the barytes continues to come from the Golconda mine, which has amply justified its reopening a few years ago and the capital spent upon its equipment. The produce of open workings in Derbyshire, that is, pickings from old lead mine dumps, shows a decline, which is not surprising, as there is now no shortage of purer material. With regard to new ventures, it is interesting to note that the old Glen Sannox mine, in the Isle of Arran, has been reopened, and the Gass Water vein, in Ayrshire, now being worked by the Hedworth Barium Company, had the respectable total of 4574 tons in 1920. A word as to the values given for the products of the several counties may not be amiss. Formerly the values were given of the mineral at the mines; in the present report, however, the figures for the Irish mines are about £5 per ton, while the higher quality Shropshire is given as about £3. Unless there is some serious error, the former must be the price at the mill and the latter at the mine. We note that the column is headed "Values," and not "Values at the mine."

Bauxite, Clays and Copper Precipitate.

Bauxite, hydrate of alumina,, and iron was produced to the extent of 11,020 tons, the highest figure since 1908. This mineral all comes from County Antrim, where it occurs in the form of seams lying between sheets of tertiary basalt. It is used in the manufacture of sulphate of alumina and of abrasive materials, for which purposes it is largely supplemented by imports from the South of France. The output of other clays comprising china clay, fire-clay, Fuller's earth, &c., were about 11 millions tons against about 7½ million tons in 1919, showing that there is now no shortage of labour. Coming to copper ore, the table relating thereto is the most meagre in our experience of these statistics, Cornwall being the only producing county, to the extent of 81 tons. Copper precipitate, obtained from mine waters in Anglesey and Cornwall and mine dumps in Devon, amounted to 194 tons, valued at £9170. This output is very little below the average of recent years, so there is no reason to suppose that this branch of our copper mining will experience the fate of copper ore mining. In view of the expert reports on the proposed copper mining venture in Shetland, it is satisfactory to note that the syndicate which had the reopening of the old properties in hand did not proceed with the scheme for a company flotation.

Fluor Spar.

Turning to fluor spar, the output was 54,683 tons, a decided increase on the 1919 figure, which was 36,860 tons. All the information given is contained in the bare summarised output, but there is no reason to suppose that there was any other source except the lead mining districts of Durham and Derbyshire. The latter county now produces much more lump ore from mines than was the case a few years ago, as the gravel spar from the old mining dumps is a rapidly wasting asset. A new dump working at the old Odin mine, near Castleton, has, however, to be recorded as having contributed to the 1920 output of gravel spar. It goes without saying that the returns for 1921 will show a diminution, as the industry depends chiefly upon the iron and steel production.

Gold.

Gold ore to a very small amount reappears in our statistics, the St. David's mine, in Merionethshire, having been reopened. The value of the bar gold was only £150, but there will have been enough metal for a certain ring, the Press notices of the origin of which have brought a flicker of interest into the topic of Welsh gold mining. In this connection it may not be superfluous to say that the precious metal always has been of erratic occurrence in pockets, and that the value of the bar gold obtained at the St. David's mine in 1904 was £73,925.

Iron Ore.

Proceeding to an ore of less intrinsic value but of greater importance—iron, to wit—the output in 1920 was 12,706,895 tons, valued at £9,956,820, of which 6,327,325, valued at £8,439,458, came from mines, and 6,379,570, valued at £1,517,362, were produced by quarrying, mainly in Lincolnshire, Northamptonshire, Oxfordshire, and Rutland. The difference notable in the above figures between the prices of mined and quarried is, of course, due to the difference in grade, the Cumberland hematite giving 52 per

cent. of iron compared with the 32 and lower percentages of the quarried ore. We note no return from the venture in the Isle of Skye, and the figure of 184 tons against 10,867 tons in 1919 from Carnarvonshire; on the other hand, the Antrim mines had an output of 28,295 tons against 15,903 tons in 1919. The Durham figure is 5026 against 14,843, and Renfrew is nil against 47,262 tons in 1919.

IMPORTS OF IRON ORE.

The large producing districts show no striking alterations, and we pass on to imported ore, which is given as 6,499,551 tons valued at £16,544,878. The usual remark is made that this ore came chiefly from Spain. This is, of course, true, but it may be mentioned that recent years have seen an increasing amount of Swedish magnetic ore coming over the Ofoten railway, to be shipped at the ice-free port of Narvik for both our eastern and western ports. One does not wish to awaken painful memories by reference to Dunderland, and the bare statement will be made that none of the Norwegian mines in the Arctic circle are now working. The Swedish mines, which before the war were largely in German hands, are now mostly owned by an important Swedish company having vessels engaged entirely in the iron ore trade. The return by the Board of Customs and Excise giving the details of our imports of iron ore from twenty or more countries is not given in the present report, so we have no figures on which to comment.

LEAD.

Passing on to lead, we note that the output of dressed ore of varying grades was 15,399 tons against 13,868 in the preceding year. The most striking features in the county returns are the reduction of 1041 tons at the Mill Close mine, Derbyshire, for so many years our premier mine, and the rise of 1041 tons (it is curious, the identical figure) from the Queensberry mine, Dumfriesshire. The latter mine, with the output of 2901 tons, takes the place of the premier mine, though the Boltsburn mine, in Weardale, runs it close. The Greenside mine, Westmorland, produced 1060 tons against 640 tons in 1919, thus again approximating to its steady average for nearly a century. It is to be hoped that the threatened break-up of this mine will be averted, though a temporary closure might be justified. The mine, which is near Ullswater, is worked by adit, and power is obtained from a turbine installation at a little distance away. Flint continues to be the only Welsh county now producing any quantity of ore, the yield from the Halkyn mountain district amounting to 1298 tons against 1386 tons in the previous year. The output from the new mine in Perthshire rose from 4 tons in 1919 to 257 tons in 1920, which is a promising result. There are no other new ventures calling for notice.

PETROLEUM.

Our space is becoming exhausted, but mention may be made of the production of 2909 barrels or 375 tons of petroleum oil at the Hardstoft well in the Derbyshire coal measure. No reference is made to the value of the oil, and in these days of strict economy it would be interesting to know the cost of production. In 1893, we may mention, our production of petroleum oil from coal mines was 260 tons, valued at £488, since which time the output has been negligible.

STRONTIUM.

A less familiar product is sulphate of strontium, a mineral dug from shallow pits in the Keuper marl of Gloucestershire and Somersetshire. The output in 1920 was 4183 tons against 1872 tons in 1919. Now that export to Germany, the principal market, is again established, we may expect a further advance towards the 1913 figure of 18,425 tons.

TIN AND ZINC.

Tin mining is not a topic to which one can refer with a light heart at the moment, but in 1920 the industry had not yet got into its present condition, and an output of dressed ore of 4858 tons, valued at £783,154, was recorded, the value being higher than that of the 5156 tons obtained in 1919. The position now seems to depend upon whether or no State help is forthcoming. Applications in 1920 were not successful, but other applications have now been made under the recent Trade Facilities Act, and developments are awaited. Under present conditions a reduction in the output of tungsten ores from 166 tons in 1919 to 94 tons in 1920 is not surprising, but there has been a renewal of uranium ore mining in Cornwall to the extent of 60 tons. Coming, in conclusion, to zinc ore, we have the record low output of 5064 tons against 6933 in 1919. The principal producers, Cumberland and Flintshire, contribute chiefly to the decline, while that good producer of a few years ago—the Great Laxey mine, Isle of Man—has only 529 tons to its credit. On the other hand, two smaller producers—Carnarvon and Montgomery—more than doubled their 1919 figures. Since 1920 the zinc mining industry has passed through a bad period. What may be the chances of complete recovery is a matter which cannot be discussed at the end of this somewhat lengthy review.

Developments in Power Station Design.

No. XXV.*

Two of the cooling towers belonging to the new Bargoed station of the Powell Duffryn Steam Coal Company were built by the Davenport Engineering Company and they are shown in Fig. 120. Each tower is designed to reduce the temperature of 216,000 gallons of water per hour from 100 deg. to 72 deg. Fah. under average atmospheric conditions. The dimensions of each tower are 90ft. 3in. long by 37ft.

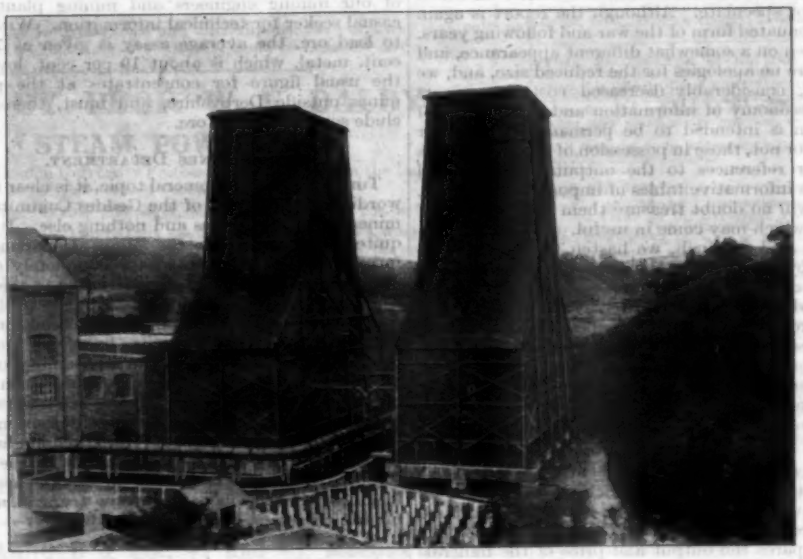


FIG. 120—DAVENPORT COOLING TOWERS

wide at the post centres and 106ft. high. The height of the water inlets is 18ft. 6in. Reinforced concrete has been employed for the construction of the foundation and the tanks. The framework of each tower, which is designed to withstand the severest gale, is constructed of Pensacola pitch pine, whilst the sheeting and interior cooling stacks are composed of the best Swedish redwood, and in order to give the towers the longest possible life the framework and sheeting were creosoted under pressure. All the straps, fish-plates, bolts and nails used in the construction of the towers are heavily galvanised. In the construction of the cooling stack, which is built on the Davenport Engineering Company's well-known principle, nails are only used for the troughing. The stack is in both cases supported directly from the foundations and is in no way attached to the tower. The irrigation is obtained by a large number of laths set with their diamond points uppermost, and they are held in position by side bearers having V notches. The side bearers are supported at distances of 5ft. 6in. throughout the length of the tower by upright guide posts, and the greatest unsupported length of each lath is 3ft. 11in. The air passages in the stack are sufficient to allow the maximum amount of air to pass into the chimney, and they are arranged so that the falling water must come into contact with the laths.

* No. XXIV. appeared February 24th.

Two large main troughs and secondary troughs—see Fig. 121—are provided in each tower for the water distribution, the latter feeding the distributing troughs or gutters by means of downcomers, which place the distributing troughs under a head. To the top of these the discharge tubes are fitted, and over these tubes there are patented sprayers, which cause the upward jet of water from the discharge tubes to be effectively sprayed over the cooling stack. Any mud deposited by the water settles at the bottom of the distribution troughs and cannot therefore interfere with the distribution unless the mud is allowed to accumulate so that it almost completely fills the troughs. Sluices are provided at each end of the troughs, so that any silt which may be kept in a state of suspension can be flushed out when required.

Five cooling towers have also been supplied by Film Cooling Towers, Limited, and Fig. 122 shows two of these towers which are in operation. They are designed to reduce the temperature of 432,000 gallons of water per hour from 100 deg. Fah. to 72 deg. Fah. at an atmospheric temperature of 55 deg. Fah. and a humidity of 75 per cent. The other three towers are capable of cooling collectively 802,000 gallons of water by the same amount. The height of each tower is 106ft., whilst the stack area of two of the towers is 63ft. by 34ft. 6in., and that of each of the remaining three towers 81ft. by 34ft. 6in. These cooling towers are built on more or less new lines, the objects aimed at by the designer being to avoid a curtain of falling water in the whole cooling area and to allow free access of air to all parts of the tower. The water from the trough falls upon a series of sprayer plates and it is then caught by a series of inclined laths, as shown in Fig. 123, and the water flows on these laths in a thin stream from the top to the bottom of the tower. As the water adheres to the laths throughout its course by means of surface tension it exposes a very large surface to the air under conditions which are favourable for cooling, whilst the disposition of the laths gives natural air shafts

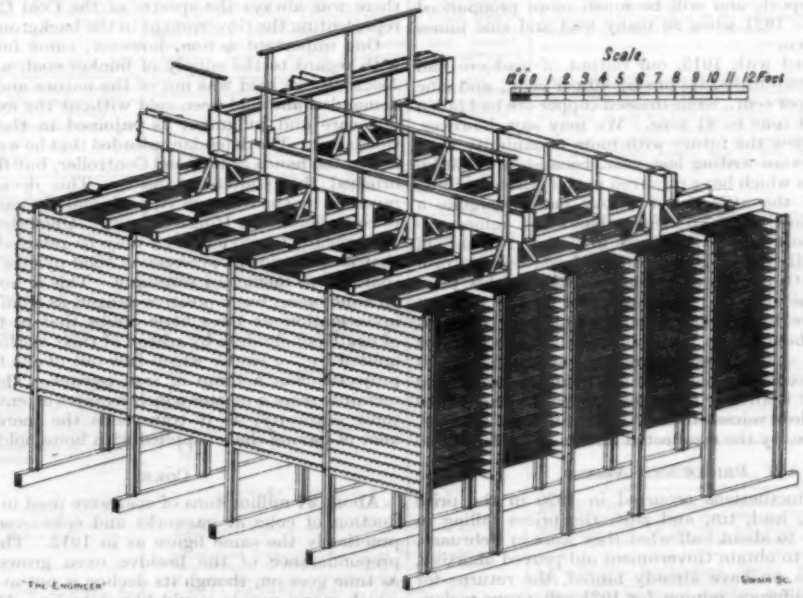


FIG. 121—ARRANGEMENT OF WATER TROUGHS AND LATHS IN DAVENPORT COOLING TOWERS

throughout the stack. The lower ends of all the laths have a V notch through which the water can flow freely on to the upper ends of the laths immediately below. Owing to the free access of air to all the parts, and to the large surface provided by the laths, this arrangement gives an excellent cooling effect. Moreover, the ground space which cooling towers of this type occupy is small for the duty that has to be performed, and the size of the catch pond can also be cut down to narrow limits.

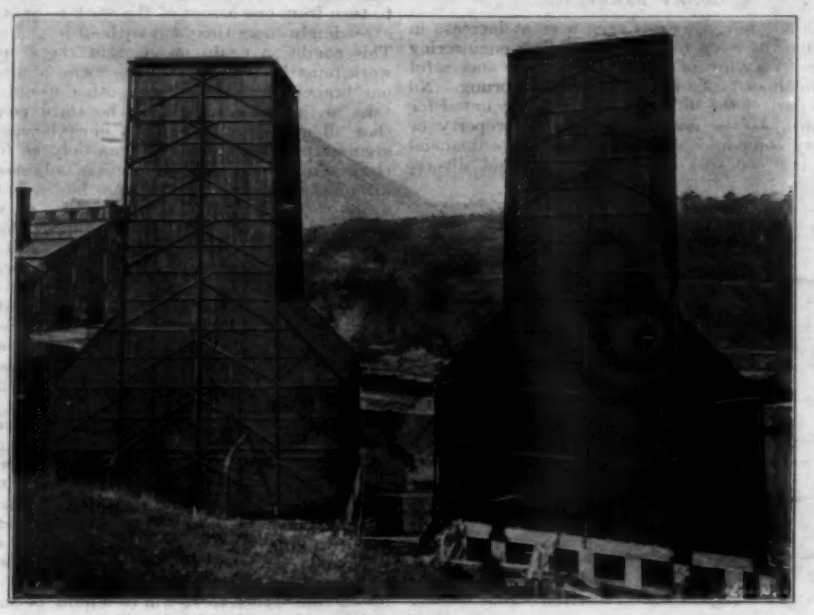


FIG. 125—FILM COOLING TOWERS

The feed pumps, which are of the turbine pattern, were supplied by Sulzer Brothers. There are two of these pumps, each capable of delivering about 10,000 gallons of water per hour against a total pressure of 370 lb. per square inch when running at about 4200 revolutions per minute. When working under these conditions the power transmitted through the coupling is about 70 brake horse-power. Steam is supplied to the turbine at the full working pressure of the boilers, viz., 350 lb. per square inch and with a temperature of 750 deg. Fah. The turbine, which is of the single-wheel type with two velocity stages, is provided with a hydraulic governor and main stop valve, the governor being controlled by the pressure produced by the boiler feed pump and boilers, and it regulates the speed so that a constant excess pressure is produced and maintained by the pump, the excess pressure amounting to about 40 lb. per square inch. The pump automatically adjusts itself to any rise or drop in the boiler pressure within very wide limits. The turbine is also fitted with an emergency governor, which automatically closes the main stop valve when the speed exceeds a certain limit. The pump, which is of the three-stage high lift centrifugal pattern, is coupled to the turbine by means of a cast steel rubber pin flexible coupling. The exhaust steam from the turbine is passed through condensing nozzles placed in the boiler feed tank with the result that a very large proportion of the latent heat contained in the steam is recovered in the boiler feed and is returned to the boiler. A view of one of these Sulzer feed pumps is given in Fig. 124.

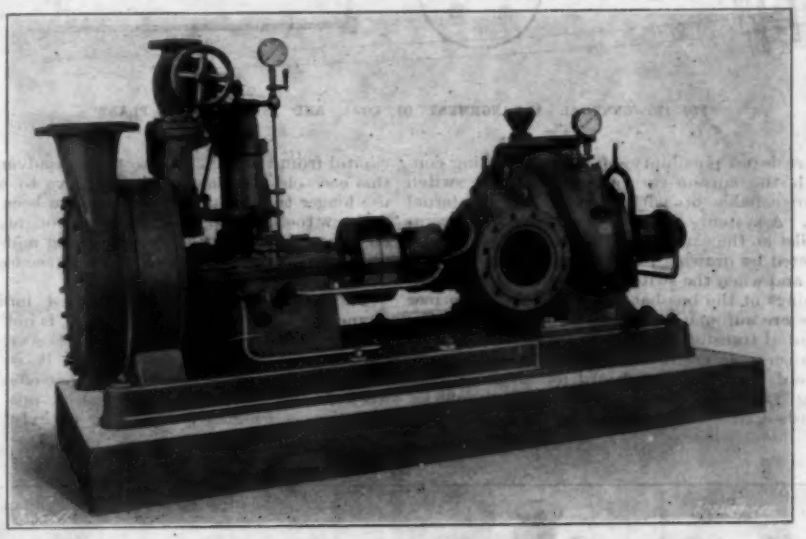


FIG. 124—SULZER TURBINE-DRIVEN FEED PUMP

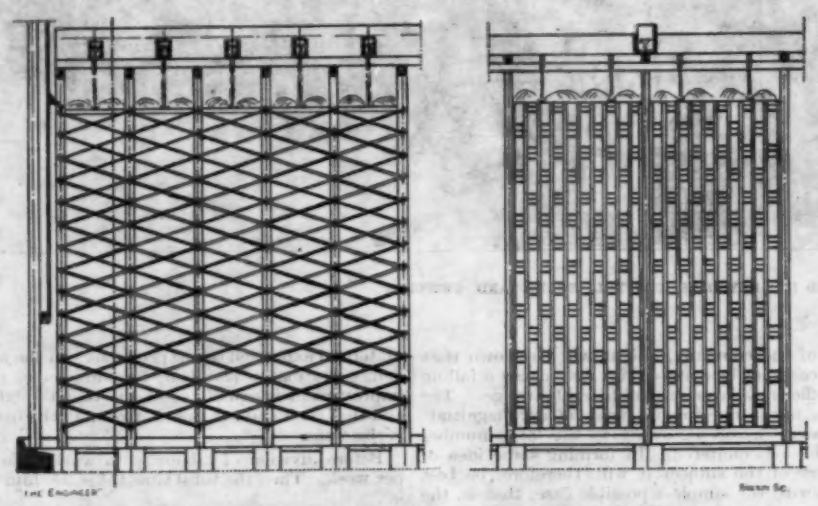


FIG. 123—ARRANGEMENT OF LATHS IN FILM COOLING TOWERS

Robert Dempster and Sons, Limited, supplied the coal and ash-handling plant, which is shown on page 302. Railway trucks are shunted on to a siding, as shown in the drawing, Fig. 125, and each truck enters in turn an electrically operated truck tipper which is arranged to rotate and tip the contents of the truck into a coal receiving hopper composed of concrete and steel plates. The contents of this hopper are fed by means of a rotary feeder on to the inclined band conveyor and deposited into the coal pit at the rate of about 30 tons per hour. From this pit the coal is handled by means of a high-speed electrically operated mono-rail telpher, which grabs up the coal, hoists it and traverses it around the circular track into the boiler-house and discharges the contents of the grab into the coal bunkers. After the ashes have been wheeled out from the boiler-house by means of hand trucks they are tipped into the ash pit, from which they are lifted by means of the same grab that handles the coal, and they are then deposited into the trucks on the railway siding. The telpher, which, as already explained, is of the high-speed type, has separate motors for the hoisting and travelling motions, and is also fitted with free barrel arrangements, which enable the grab to be lowered by gravity. With gross loads up to 4¼ tons the hoisting speed is 75ft. per minute, whilst the travelling speed on the straight track is about 500ft. per minute.

The switchgear, which was supplied by the Metropolitan-Vickers Electrical Co., is designed to control two 12,000-kilowatt generators, one 5000-volt generator, six split conductor feeders, four solid feeders, and two sets of bus-bar sectionalising apparatus. The cubicle structure is composed of moulded stone, which is mounted in a steel framework, whilst the control panels are of the desk type. The main switches, which are designed to deal with 11,000-volt, 50-cycle current, are electrically operated. One of the generator panels for a 15,000-kilowatt set may be taken as a typical equipment. It is provided with three 1000-ampère isolating switches with safety catches, one electrically operated oil switch, two compound-filled current transformers for supplying current to the instruments, three compound-filled current transformers for the Merz-Price protective gear, three corresponding transformers for the neutral, and one single-phase oil-immersed potential transformer for the instruments and synchronising gear protected by expulsion type fuses. The corresponding desk panel is fitted with a push button controller for closing and opening the oil switch by means of a contactor, so that the contacts of the push button are only required to deal with a very small amount of current. Red and green lamps indicate the positions of the oil switch. A separate push button is provided for opening the main oil switch and field switch in the case of emergency. There are also indicating and integrating wattmeters, an induction type ammeter, reading up to 1000 ampères, a power factor meter, a polyphase reverse power relay, a polyphase overload relay, a three-pole Merz-Price relay, a turbine governor control switch, and a control switch for the electrically operated rheostat. Each of the split conductor cubicles contains three 500-ampère isolating switches with safety catches, a 600-ampère electrically operated oil switch, two split conductor current transformers for the instruments, three split conductor protective transformers for use with the relays of the split conductor balanced voltage system, a single-phase potential transformer for the instruments, synchronising gear provided with expulsion fuses, and six isolating switches with safety catches for feeder terminals.

The corresponding apparatus on the desk panel is composed of a push button controller for operating the oil switch, together with indicating lamps, &c., an indicating induction wattmeter with a central zero, two integrating watt-hour meters, one for measuring the incoming power and the other the outgoing power, an induction type long-scale ammeter, a polyphase power factor meter, a polyphase overload relay, and a three-pole split conductor relay for feeder balance protection. Synchronising receptacles are fitted on both generator and feeder panels for bringing the synchronising instruments into operation. The solid conductor feeders are provided with practically the same apparatus, with the exception that there are no special relays and transformers as used with the split conductor system of protection. Some electrical plant, including electric winders and synchronous induction motors, is also being supplied by the Metropolitan-Vickers Electrical Company for use at various collieries.

Reyrolle and Co., of Hebburn-on-Tyne, have supplied eight 3300-volt remote electrically controlled ironclad panels and one hand-operated bus-bar connector panel for use in connection with various transformers and motor circuits associated with the station, and the 3000-volt system of the Bargoed colliery adjoining the power-house. Five of these panels are fitted with Merz-Price protective gear. Fig. 127 shows a group of these Reyrolle switches, which are operated from a control board and which have all the conductors enclosed in a metal covering. The bus-bar current transformers and other live parts are immersed in compound, and the switches themselves are under oil, so

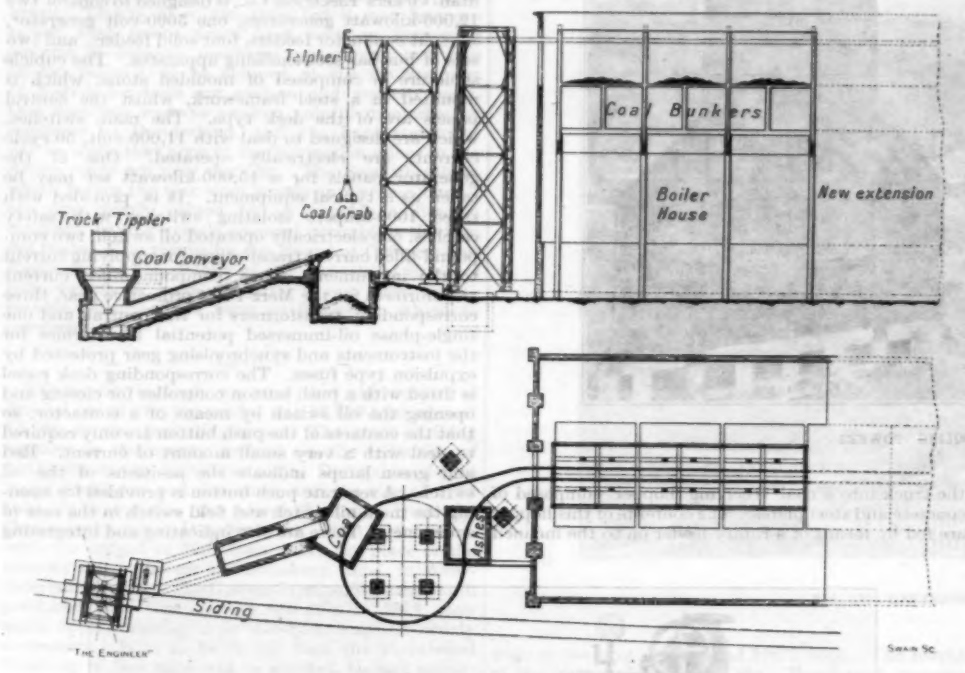
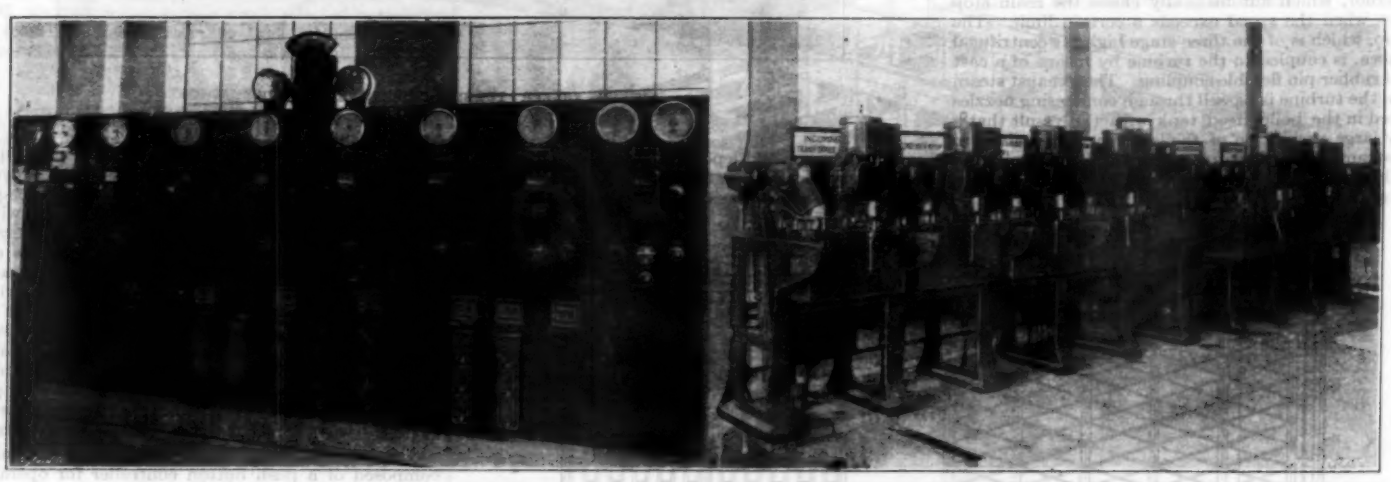


FIG. 125—GENERAL ARRANGEMENT OF COAL AND ASH-HANDLING PLANT

that there is no possibility of anyone making contact with the current-carrying parts. The switch tanks are capable of withstanding heavy internal pressure. A system of interlocks ensures safe operation, whilst at the same time the switches can easily be inspected by drawing them out in the well-known manner, and when the switches have been withdrawn the openings of the bus-bar and current transformer chambers are automatically screened off by shutters. The potential transformers, which are in separate cast iron chambers, can easily be detached for the purpose of overhaul. The control board for these switches —see Fig. 126—is composed of sheet steel cubicles with polished slate slabs on the front, on which are



FIGS. 126 AND 127—REYROLLE CONTROL BOARD AND SWITCHES

mounted master switches, "on" and "off" indicating lamps, meters and protective relays. The control wiring running from this board to the ironclad gear shown in Fig. 127 is of the multi-core lead-covered type. At the outlying collieries 11,000-volt current is also controlled by Reyrolle switchgear.

THE cost of completing the electrification of the Brighton line between London, Brighton and Lewes was estimated at seven millions in 1913; the cost to-day would be ten millions.

Considerations on Factory Size and Efficiency.

By HENRY BAKER, B.Sc.

THE last dozen years has seen a great increase in the number of large factories and large engineering concerns. Very few of them have been as successful as the small factories from which they sprung. No doubt a part of the difference is to be accounted for by finance, as the acquisition of new property or subsidiary companies often causes a severe financial drain on a concern of moderate size and diverts capital from the old shops to their disadvantage. In this case old-fashioned machines have to be kept in use longer than would otherwise have been the case, and new tools and appliances are not bought. Expense on experiment in both manufacturing and organisation is economised, and the company recedes from the front rank in efficiency.

The engineer, although interested indirectly in finance, for the reasons shown above, is not primarily concerned with it, and can find other reasons for variation of efficiency with size. It is generally supposed, in a rather vague way, that efficiency of a works increases with size. That is not so. The variation is irregular, depending entirely upon the product of the company, and it will be shown that in some cases an increase of size may cause a falling off in efficiency over a considerable range. The discussion of this question for a case of any magnitude is necessarily involved, owing to the large number of variables encountered. In forming some idea of the theory of the subject it will, therefore, be best to begin with the simplest possible case, that is, the case of a one-man factory.

Under what conditions can a "factory" consisting of one man be run efficiently? First, the nature of the work must be such that it is all properly allocated to a man of the capacity of that one man. This condition at once precludes any large variety of work, for if any work capable of being done by a boy or by less skilled labour comes along, then the ideal efficiency of the establishment is at once lowered. The second condition is that the man must be able to turn from one aspect of the work to another in an exceedingly short time and without loss of efficiency. This condition again means that the scope of the work must be limited; for otherwise a change from one branch of the work to another would certainly take an appreciable time. The third condition is that all machinery and plant must be used to the greatest possible extent. It can only be fulfilled in the one-man factory where there is only one piece of machinery or plant in use. As, however, this condition cannot be fulfilled anywhere for all work, the single worker does not suffer unduly if the work is carefully chosen. For example, a patternmaker uses a whole chest of tools, but it is not practicable, even in the largest factories, so to apportion the work that one man uses only, say, a chisel and another only a tenon saw. Consequently, in the case of patternmaking a single worker would be as efficient as a large factory if the work was very variable.

From the foregoing considerations it will be seen that any expansion would involve two separate fields in which improvement might be expected. First, from the division of labour. Secondly, from the division of the functions of machinery and plant. Considering the division of labour first, it may be noted that in very abstract pure theory the improvement which may be expected from this source is never ending if we assume that no time is lost in passing the work from one specialised worker to another. If, however, this transfer time is taken into account, then there will be a limit of subdivision of labour beyond which it will not pay to go. This may be called the practical limit of economy with subdivision of labour, or more shortly the subdivision maximum. Proceeding from no subdivision to the subdivision maximum, the amount of gain at each further subdivision will be by no means uniform. The main advantage will be gained at the first few subdivisions which enable the workers to drop those sections of the work at which they are really second rate; then will follow a period of more moderate gain as each worker is allocated to the field of work in which he is expert; then will follow a period of much lesser gain as the workers get into a particular section of the field of work at which they are expert, in which section they may reach the human maximum. This hypothesis may be represented by a curve as shown (Fig. 1). It is drawn by guesswork, but its general shape has been proved by the arguments adduced above. It is intended to apply to works making an article of moderate complexity.

From the curve it will be seen that to increase the size of a works beyond a certain point has little to recommend it from the point of view of labour subdivision. What the point will be at which the gain due to this cause becomes small will depend on the number of different operations performed.

The most economical number of operations into which to split a given job can be determined if the improvement effect can be expressed as a function of the number of divisions. That it can be approximately so expressed seems probable. In the following demonstration it is taken, for simplicity, that the improvement is equally good due to all subdivisions, and that the handling time between all the operations is the same.

Before division of labour let a worker do n units per week. Then the total time taken by him per unit is

$$\frac{1}{n} \text{ weeks} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Then if h weeks be the handling time (consisting of receiving the unit and passing it on; not including

any other handling time) the original net working time is

$$\left(\frac{1}{n} - h\right) \text{ weeks} \quad . \quad . \quad . \quad . \quad (2)$$

The work is now split up into p additional operations involving a handling between each. Then, unless the worker goes faster, he must now take $\left(\frac{1}{n} - h\right)$ weeks as before, plus $p \times h$ weeks' handling time, making a new total time $p\,h + \left(\frac{1}{n} - h\right)$. This is greater than $\frac{1}{n}$, or, in other words, the splitting up of the work will cause a loss of time unless the work be done faster. Suppose, then, that the efficiency on the net working time increases as $f(p)$ where $f(p)$ is a function of p determined from experience. Then the net working time is reduced to

$\left(\frac{1}{n} - h\right) \times \frac{1}{f(p)}$, and the new total time is

$$p\,h + \frac{\left(\frac{1}{n} - h\right)}{f(p)} \quad . \quad . \quad . \quad (3)$$

Then the ratio of the old total time to the new total time is the fractional improvement for the whole job k.

Then

$$k = \frac{\frac{1}{n}}{p\,h + \frac{\left(\frac{1}{n} - h\right)}{f(p)}} = \frac{1}{n\,p\,h + \frac{1 - n\,h}{f(p)}} \quad (4)$$

We require this ratio to be a maximum with variation of p so that we obtain the required condition by differentiating with respect to p and equating the result to zero. The condition is

$$n\,h + \frac{(n\,h - 1)f'(p)}{\{f(p)\}^2} = 0$$

or

$$n\,h\,\{[f(p)]^2 + f'(p)\} = f'(p) \quad . \quad . \quad . \quad . \quad (5)$$

In other words, maximum efficiency can only be obtained when the number of articles made per week is an exact multiple of the integer numbers representing the ratios of the operation times. This proves the statement originally made that an increase of size may not cause any increase in efficiency. When m units are made the efficiency is a maximum. Increasing the number of units made from m will now result in a lowering of efficiency, over the range m to $2\,m$, but at $2\,m$ the maximum will again be reached. Increasing the size over $2\,m$ will again result in lower efficiency, but nevertheless, the efficiency will be higher than over the range m to $2\,m$. The general tendency can best be followed from the sketch of the graph of increase of efficiency with size shown in Fig. 2.

From this curve it will be seen that here, again, the large factory has very little or no advantage over the small one provided that the work in the latter is well balanced. This is to say that it is so distributed that each worker can spend the whole of his time on one operation on which he is expert.

In the case of the one-man factory previously considered the theorem proved above is illustrated in a striking manner; for if that one man wishes to subdivide his work he must increase the size of his works by an integer number. That is to say, he must double it. Consequently he suffers loss of efficiency until his business is doubled. If the subdivision of labour is now the best possible he will lose efficiency on engaging a third man, but attain a maximum again with the fourth. This example postulates two operations, each of equal duration. When the second man was first engaged, but the output had only just increased above the capability of the one man, the drop in efficiency was nearly 50 per cent., but when the third man was engaged under similar minimum conditions the drop in efficiency was only about 30 per cent. In practice the one-man business would, of course, accommodate itself more gradually by means of overtime, &c., but that is beside the point. It is sufficient for our present purpose to see that the shape of the graph—Fig. 2—is correct for this case.

Turning now to the second consideration, of the subdivision of the functions of machinery and plant, the theoretical considerations involved are much the same as in the case of the division of labour. The gain of skill of the workman in the latter case is paralleled by the greater power of the machinery in the former. It now becomes necessary for maximum efficiency to employ an integral number of each class of machine at maximum capacity, but the issue is complicated by the fact that the efficiency is not then necessarily a maximum if one operator can work more than one machine. If this be the case then for theoretical maximum efficiency, if r machines of one class would otherwise be required (i.e., if one operator could work only one machine), and an operator can most economically work s machines, then the best number of machines will be the L.C.M. (least common multiple) of r and s (or any other multiple). When these L.C.M.s have been found they will, in general, then upset the original numbers determined for each class of machine. Usually each of these original numbers will have to be multiplied by the L.C.M. of the integral ratios of the L.C.M.s just determined for individual cases, so that the issue in this case becomes rather complex. The general tendency will here be seen, however, to favour the large factory more than was the case when considering the subdivision of labour only. That this theory holds in practice is verified by the fact that it is where expensive and varied machinery is employed that the large works stands a better chance of being successful in competition with the small one. It is to be noted, however, that if in any particular case the number of machines of each class required, as calculated above, did not prove to be a very large number, then the small factory would again be quite as efficient, on this account, as a larger one. Further, it is interesting to note that the range over which a loss of efficiency is caused by increase of size is greatly extended if the L.C.M.s as found happen to be very big numbers.

In the foregoing investigations we have considered the splitting up of a unit of work. The size of this unit can be taken as anything we please from the activities on one small part, say, a spoke, to those on a complete product, say, a motor car. The form of the function of increase of efficiency with subdivision will, however, be different in each different case considered. Further, our assumption has been that the improvement due to each subdivision was equal. This, however, would rarely be the case, because one of the chief economies of the division of labour is to enable some of the subdivisions to be performed by a cheaper class of labour. In these cases an exceptionally high increase would result, and the ensuing theoretical investigation would, of course, involve the insertion of appropriate factors for each varying case.

Returning to the question of the size of unit work considered, the larger this is the more favourable is the result to the larger factory. Going back to equation (6), and altering only the value of n, making it $\frac{1}{10}$ instead of 100, we find that the solution of the equation is then about 1000 instead of 7 as formerly. That is to say, that whereas with a job of half an hour's duration it only paid to subdivide it into 7 divisions, with a job of 10 weeks' duration it would pay to subdivide it into 1000 divisions (assuming the same law and same handling time to hold). This minute subdivision would only be possible in a very large factory; but, on the other hand, the loss due to adopting only, say, 100 subdivisions would be comparatively small—see Fig. 1—so that the small factory is not so much handicapped as might at first appear.

Into the financial aspect of "compounding" factories making quite different articles, with the object of saving transport and merchants' profits, it is not the function of this article to investigate, though several lines of attack should be suggested by it. Our object is simply to point out that if intelligence is exercised in carefully balancing the flow of work, then, quite apart from considerations of finance or organisation, a factory of moderate size has nothing to fear from a very large one. It can usually be made quite as efficient, and may, in fortuitously favourable circumstances, be slightly more so. The mathematical investigations have shown this clearly, and we are thus left free to search for any additional influences other than production influences which may affect the problem.

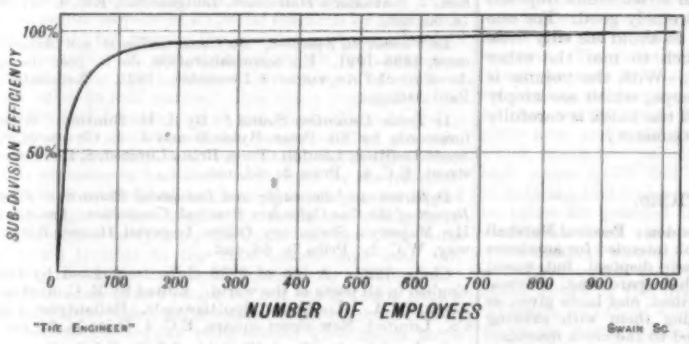


FIG. 1

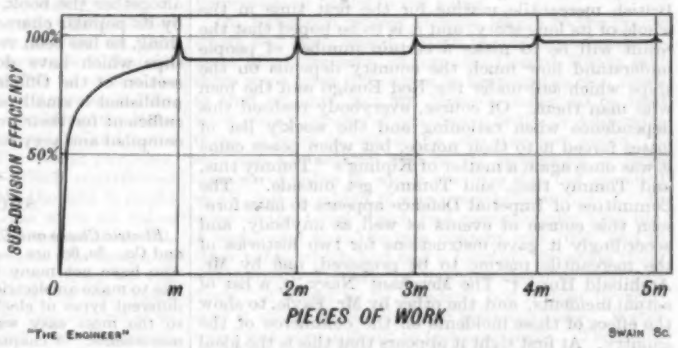


FIG. 2

For example, if

$$f(p) = s \log p + 1$$

equation (5) reduces to

$$n\,h\left[s^2(\log p)^2 + 2\,s \log p + 1 + \frac{s}{p}\right] = \frac{s}{p} \quad (6)$$

If we take $s = 3{\cdot}15$, $n = 100$ and $h = \frac{1}{3000}$, then solving equation (6) by trial we find that p is about 7. That is, in this case it would be most efficient to divide the unit operation considered into eight detail operations.

The above investigation assumes that the required number of workers can be placed on the job when subdivided just as well as before subdivision. This assumption, however, is only justifiable if the workers can change from one operation to another without loss of time and without disturbing other workers or the flow of work. These conditions seldom hold, and in practice a serious loss of efficiency results if the worker has to change from one operation to another. The cause of loss of efficiency under this head is twofold, consisting, first, of actual loss of time during transfer, and, secondly, of loss of skill or knack on the one operation while performing the other.

To investigate the condition that the work can be economically placed when subdivided, we suppose the p operations into which the unit has been split each to take α, β, γ, δ . . . units of time where α, β, γ . . . are the smallest possible integers, and let m be the number of the same units in the working week. Then if there are l units to be made per week the number of workers required on each operation is $\frac{l\,\alpha}{m}$, $\frac{l\,\beta}{m}$, $\frac{l\,\gamma}{m}$ . . . For maximum efficiency each of these expressions must be an integer; for a fractional number means that, in practice, the next higher number has to be engaged, with consequent loss of efficiency. In general, these expressions will only be integers when $l = m$ or some multiple of m, since at least one of the numbers α, β, γ, . . . will be a prime.

of material and waste of labour, the executive ability at the head of affairs must be very high. It must also be of quite a different kind from that required of the head of a small works. That is why experienced men are so difficult to get, and why the man promoted from a smaller place so frequently fails.

The number of large factories in the engineering industry has grown faster than an understanding of how to control them. There is a lack of suitably trained staff for organising and almost an entire absence of staff used to being organised. That the large factory is not run as efficiently as the small one can be briefly proved by the fact that not one can efficiently execute jobbing work. Until some of the more modern conceptions of management are better known it does not seem likely that the very large factory will develop the efficiency which might be expected of it on purely production grounds. The difficulties have, of course, been overcome in exceptional cases either where the product was simple or where the management was exceptionally determined, but these cases have, up to now, been few and far between.

In conclusion, then, it appears that the factory just large enough to be well under the control of one man probably represents the most efficient size at the present time. The production advantages of the large factory have been overrated and the difficulties of management underestimated. The future of the large factory depends on overcoming the difficulties of management, while that of the smaller depends on so choosing the nature and quantity of the product that a nearly exact economical balance may be maintained.

Literature.

Seaborne Trade. By C. ERNEST FAYLE. Being part of the Official History of the Great War. London: John Murray, of Albemarle-street. Price 21s. net.

IN the Official History of the late war with Germany attempts are being made to do full justice to the British mercantile marine for the first time in the whole of its long story, and it is to be hoped that the result will be to make a certain number of people understand how much the country depends on the ships which sail under the Red Ensign and the men who man them. Of course, everybody realised this dependence when rationing and the weekly list of losses forced it to their notice, but when peace came it was once again a matter of Kipling's "Tommy this, and Tommy that, and Tommy get outside." The Committee of Imperial Defence appears to have foreseen this course of events as well as anybody, and accordingly it gave instructions for two histories of the mercantile marine to be prepared, one by Mr. Archibald Hurd ("The Merchant Navy"), a list of actual incidents, and the other by Mr. Fayle, to show the effect of these incidents on the commerce of the country. At first sight it appears that this is the ideal arrangement, for one is always ready to say that such a theme as has been allotted to Mr. Fayle cannot avoid being as dull as ditch water, and therefore only read by experts, while the actual doings of the merchant service deserve, and should have, a far wider circulation. But Mr. Fayle has put an end to this argument by writing in a really remarkable manner, and has made his apparently very technical subject extraordinarily vivid and interesting. We are therefore inclined to wish that the history of the merchant navy had been compressed into one series of volumes, for thereby a large area of ground would not be covered twice, and both student and layman would have got a very much better idea of what actually occurred and its real meaning. However, the Committee decided otherwise, and one can only express a certain amount of regret and enjoy the book nevertheless.

The subject is not by any means an easy one, and the author has dealt with it in a very efficient manner, without any lack of balance, and, as we have said before, without any dulness. The first volume deals with the cruiser period, and runs down to the time when the submarine made its first appearance against peaceful commerce and the practically simultaneous end of the last of the considerable fleet of corsairs which Germany let loose on British commerce at the outbreak of war. It is a period of extreme interest to the student, and one about which the layman can read without the disgust which the later atrocities of the enemy cannot fail to arouse. For the captains of the early German cruisers behaved according to the accepted ethics of the sea, and if a sailorman fell into their hands he looked on it as bad luck, but parted with them without feelings of bitter loathing.

To begin with, the whole question of British and foreign trade and shipping is sketched, a very necessary introduction to such a work as is proposed. The various financial factors of modern sea-borne commerce are also carefully explained, and this again is very necessary on account of the difficulties which they placed in the way of our administrators forming their plans during the first few days of the war. When war broke out nothing was prepared, and nothing had been foreseen to the extent of making any definite arrangements. Sundry Royal Commissions had met and talked and parted again without taking a really strong line and doing anything of practical use. When war was actually upon us the gravity of the question of food supplies and commerce was realised, and everybody set to work in a hurry to improvise working arrangements. The Government turned to the right men in their difficulties, and arrangements were made without difficulty. These arrangements, or most of them, worked exceedingly well either until something better could be devised or until their utility was checked by the number of eager helpers anxious to do work of national importance. Others, again, survived in practically their original form right down to the time of the Armistice, and the names of the men who served their country by conceiving such plans deserve to be remembered.

In those early days, of course, everything at sea was in confusion. Not only were there innumerable unknown factors to contend with, but hundreds of British ships had to be warned at the same time as hundreds of Germans were scooped up and captured. The control of the Atlantic terminals seemed to be the most pressing problem, partly on account of the ease with which enterprising cruisers could then have slipped to sea, and partly because there were so many fast liners in American harbours which could have got away and made ready to raid our commerce at the shortest notice. Two things were not known, one that the German navy had no taste for slipping to sea and fighting when it could be avoided, and the other that fast Atlantic liners were practically useless as auxiliary cruisers. This latter fact had to be learned by the enemy as well as by ourselves, but ignorance of it had a considerable influence on the first few weeks. Then mines in the North Sea caused a lot of trouble, and had to be dealt with according to the knowledge that we had of them. No sooner were they covered than our Far Eastern and Australian trade had to be attended to, for it ran on such regular routes that it offered ideal opportunities for enterprising corsairs, opportunities of which the Emden later took very full advantage. Every one of these phases had its immediate effect on shipping and on the commerce of the country, and they were felt to an extraordinary degree in all sorts of unexpected directions. These directions are carefully enumerated by the author, and altogether the book, within the strict limits imposed by its popular character, is extremely good. For one thing, he has been very careful to avoid the silly little slips which have done so much to mar the other section of the Official History. With the volume is published a small packet of maps, which are amply sufficient for their purpose, and the index is carefully compiled and very tolerably satisfactory.

SHORT NOTICES.

Electric Clocks and Chimes. London: Percival Marshall and Co. 3s. 6d. net.—A little book intended for amateurs who have not many tools at their disposal, but would like to make an electric clock in their spare time. Several different types of clock are described, and hints given as to the most easy way of making them with existing movements. A chapter is devoted to the clock manufactured by the Synchronome Company, which is willing to supply parts to amateurs who wish to make a clock for themselves.

Les Relations Economiques entre La Grande-Bretagne et La Suisse dans le Passé et le Présent.—We have been favoured by the Swiss Legation with a copy of a book by Dr. William Waldvogel, entitled "Les Relations Economiques entre La Grande-Bretagne et La Suisse dans le Passé et le Présent." In it, the author gives a comprehensive survey of the origin, development, present importance and future scope of Anglo-Swiss trade. He commences in the sixteenth century and brings his story down to the present day. It is shown how that during the war Switzerland provided Great Britain with aniline dyes, fine and pharmaceutical chemicals, parts of ammunition, &c., while the United Kingdom, on her part, took an important share in providing Switzerland with many commodities which formerly were sold to her by Germany. The author also examines the new Swiss Customs tariff and the recent English Dye-stuffs and Safeguarding of Industries Acts, and seeks to gauge their probable effects on the future development of Anglo-Swiss trade. The economic relations of Switzerland with the British Dominions and Colonies are also considered in the light of the most recent developments in commercial policy. The book contains numerous statistical tables, and gives the text of treaties and a full list of the literature relating to the subject, as well as an account of the progressive development of an important Swiss colony in the United Kingdom, especially in London. The volume, which is written in French and which is intended to be a source of information and reference to all those who wish to get more closely informed concerning the trade relations between Great Britain and Switzerland, can be obtained from the Frederick Printing Company, 21, Garlick-hill, London, E.C. 4, price 7s. 4d. post free.

Year Book of Wellington Harbour Board—New Zealand.—Following the example of various home ports the Harbour Board of Wellington, New Zealand, has prepared and issued an exceedingly well got up and illustrated Year Book. Wellington Harbour is a well-nigh land-locked sheet of water having an area of about 20,000 acres. The depth of water in it varies from 6 to 14 fathoms, and in it the entire British Fleet might be safely accommodated. The entrance at the narrowest part is 3600ft., and the depth in it varies from 7 to 8 fathoms. The current in the entrance never exceeds 2 knots, and the extreme limits of rise and fall of the tide are 2ft. 6in. and 4ft. 6in. The harbour is situated at the south end of the North Island, facing the channel between the two islands, and these facts, combined with the facilities which have been provided for shipping, make it the chief distributing port of New Zealand. The Year Book gives particulars of every kind likely to be of service to those intending to make use of the port, as well as a series of charmingly reproduced photographs. By no means the least interesting section is that devoted to an account of the discovery of the port and of the early settlers.

BOOKS RECEIVED.

Chemistry, Part I. By George Thompson and G. H. Leslie. London: Cassell and Co., Limited. Price 2s. net.

Sierra Leone Government Railway: General Manager's Report on the Accounts and Working for the Year 1920.

Calvert's Mechanics' Almanack, 1922. Manchester: John Heywood, Limited, 121, Deansgate. Price 6d. net.

Heat. By George Thompson and George H. Leslie. London: Cassell and Co., Limited, La Belle Sauvage, E.C. 4. Price 2s. net,

Fifth Report of the Indian Railway Bridge Committee, October, 1921. Delhi: Railway Board of India. Price 1 rupee.

The Swedish Year Book, 1921. London: Williams and Norgate, 14, Henrietta-street, Covent-garden, W.C. Price 7s. 6d. net.

Practical Least Squares. By O. M. Leland. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. 15s. net.

The Practical Electrician's Pocket Book and Diary, 1922. London: S. Rentell and Co., Limited, 36–39, Maiden-lane, W.C. 2. Price 3s. net.

The Textile Manufacturer Year Book. 1922. London: Emmott and Co., Limited, 20, Bedford-street, Strand, W.C. 2. Price 3s. 6d. net.

The "Mechanical World" Year Book, 1922. Manchester: Emmott and Co., Limited; and Bedford-street, London, W.C. 2. Price 2s. 6d. net.

Switching Equipment for Power Control. By Stephen Q. Hayes. London: McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. 21s. net.

The Year Book of the Scientific and Learned Societies of Great Britain and Ireland. London: Charles Griffin and Co., Limited, Exeter-street, Strand, W.C. 2. 15s. net.

Lockwood's Builders' and Contractors' Price Book, 1922. Edited by J. P. Allen. London: Crosby Lockwood and Son, 7, Stationer's Hall-court, Ludgate-hill, E.C. 4. Price 7s. 6d. net.

Le Tunnel du Simplon. Sa Construction et son Achèvement, 1898–1921. En commémoration de la posé de la dernière clef de voûte 4 Decembre, 1921. Neuchatel: Paul Attinger.

Is Trade Unionism Sound? By J. H. Bunting. With forewords by Sir Peter Rylands and J. R. Clynes, M.P. Second edition. London: Benn Bros., Limited, 8, Bouverie-street, E.C. 4. Price 2s. 6d. net.

Department of Scientific and Industrial Research: First Report of the Gas Cylinders Research Committee. London: His Majesty's Stationery Office, Imperial House, Kingsway, W.C. 2. Price 7s. 6d. net.

Clubs, 1922. A list of 3936 clubs frequented by the English in all parts of the world. Edited by E. C. Austen-Leigh, M.A. London: Spottiswoode, Ballantyne and Co., Limited, New-street-square, E.C. 4. Price 7s. 6d. net.

Coal and Smoke. By J. W. Cobb, C.B.E., F.I.C. Reprint from the *Edinburgh Review*, October, 1921, by permission of Messrs. Longmans, Green and Co. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 1s. post free.

Report of the Interdepartmental Committee appointed to Consider the Methods of dealing with Inventions made by Workers aided or maintained from Public Funds. London: His Majesty's Stationery Office, Kingsway, W.C. 2. Price 6d. net.

Factory Accounts in Principle and Practice: Garcke and Fells. Seventh edition revised to date. With a foreword by J. M. Fells, C.B.E. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, Ludgate-hill, E.C. 4. Price 15s. net.

Department of Scientific and Industrial Research, Fuel Research Board. Special Report No. 1, Pulverised Coal Systems in America. By Leonard C. Harvey. Revised edition. London: His Majesty's Stationery Office, Kingsway, W.C. 2. Price 5s. net.

Ministry of Munitions, Department of Explosive Supply: Preliminary Studies for H.M. Factory, Gretna, and Study for an Installation of Phosgene Manufacture. Volume supplied by Wm. Macnab. London: His Majesty's Stationery Office, Kingsway, W.C. 2. Price 15s. net.

The Failure of Metals under Internal and Prolonged Stress. A general discussion held jointly by several Institutions. Edited by F. S. Spiers, O.B.E., Secretary of the Faraday Society. London: The Faraday Society, 10, Essex-street, Strand, W.C. 2. Price 10s. 6d. net.

Financial Review of 1921, *including Fluctuations in the Rates of Foreign Exchanges and the Prices of the Raw Materials of Industry.* By J. S. M. Ward and A. L. Please. London: The Intelligence Branch of the Federation of British Industries, 39, St. James-street, S.W. 1. To members free: non-members, 1s. 6d.

The Albert Owner's Handbook and Catalogue of Spare Parts. Part I.: Description and Instructions. The 11.9 *Horse-power Albert G* 3, *manufactured by Gwynnes Engineering Company, Limited, Chiswick.* London: Sole Concessionnaires, the Service Motor Company, Limited, Service House, 94, Great Portland-street, W. 1. Price 5s.

Applications de la Biologie a l'Art de l'Ingénieur. Hygiène des villes, des armées et des chantiers de travaux. Travail dans l'air comprimé, raréfié, trop chaud ou trop humide (milieux irréspirables). Leçons professées à l'École des Ponts et Chaussées, par le Docteur Ed. Imbeaux, Ingénieur en Chef des Ponts et Chaussées. Paris: Dunod, Editeur, 47 et 49, Quai des Grands-Augustins, Paris-VI°. Price 13f. 50.

Institute of Metals.

No. II.*

AN interesting discussion followed the presentation by Dr. G. D. Bengough of his "Notes on the Corrosion and Protection of Condenser Tubes," of which an abstract appeared last week.

Dr. H. E. H. Carpenter, who is chairman of the Corrosion Committee of the Institute, said that the notes had been compiled for the benefit of the practical man, and represented the considered conclusions of Dr. Bengough and his colleagues in the research work.

Sir Gerard Muntz, representing the manufacturers' point of view, made a brief review of the whole situation. He could not agree, he said, that in all ordinary cases tubes made of Admiralty alloy should be employed, and, indeed, Dr. Bengough had produced evidence that out of five classes of water likely to be used, in only one case was Admiralty alloy the material which gave the best results. As the author suggested, it would, of course, be possible to supply tubes containing less than 0.1 per cent. of iron. That was very often done, but it necessitated the use of the very purest metals obtainable and the greatest possible care in the manufacture, so that if makers were required to give a guarantee to that effect it was probable they would ask a very high price for such tubes. Pre-oxidised or low-temperature annealed tubes would probably be well worth a trial, but it was yet to be proved how such tubes would stand ordinary service conditions. It seemed quite possible that the surface film would only be beneficial for a short time, and that, after it had been penetrated, the tube would fail in the ordinary way, like any other tube. That process would, of course, add to the cost of the tubes, and therefore, unless it was shown to be beneficial, would not be worth the money. The corrosion set up by leaky ferrule packing was usually of a special kind, and attacked the outside of the tube just inside the ferrule, and was a matter solely in control of the engineer in charge; the tube maker had no part in it. Foaming depended very much on the structure of the condenser, the pump inlet shape, and its position as regards the water surface. Those were points worthy of a special research by engineers, and should not require the assistance of metallurgists or chemists. It was satisfactory to find attention drawn to the grave dangers of starting off the life of new tubes in foul waters. For many years past tube makers had been trying to get shipbuilders and ship engineers to understand the danger of that practice, but, unfortunately, with very little effect. Now that their statements had been confirmed by an independent and undoubted authority, it was to be hoped users might at last realise there was something in it. Water of low temporary hardness had been the cause of much trouble to the tube maker and user, but 70/30 brass tubes had been persistently specified and used, whereas there could be but little doubt that a nickel-copper tube, an arsenical-copper tube, or even a plain tough copper tube would give much more satisfactory results. A few users had already discovered that fact, and he hoped that others would now see light in that direction. A 2 per cent. lead brass had, within the last few years, been largely and satisfactorily employed under such conditions, where water had had to be drawn from brackish sources, or where ships had had to ply in brackish estuaries, or lie in docks known to have such water; and those lead-bearing brass tubes had, with scarcely any exceptions, given most satisfactory results. In waters with moderate chloride contents but with considerable dissolved carbon dioxide, nickel-copper tubes had, in many instances, given eminently improved results as compared with any brass tube. Copper-tin had been tried in Australia as sheathing on dock and wharf piles, but had not proved very satisfactory, often being violently attacked by corrosion on the water line. An 80/20 nickel-copper was an expensive tube, both owing to the high cost of nickel, and also to the difficulties of manufacture, which were considerably greater than those experienced with brass. Nickel-copper of even 2 per cent. stood up very well under many conditions, and an alloy of 6 per cent. of nickel-copper gave as good a result, in many cases, as one of 20 per cent.; it was also cheaper and easier to make. Nickel-copper had not, so far, been proved satisfactory in sea water under actual service conditions. Either arsenical copper or nickel-copper would no doubt be more efficacious than brass, but in the case of nickel-copper an alloy of 2 per cent. would usually be sufficient, and 6 per cent. would be quite as good as 20 per cent. in most cases.

One of the most satisfactory features of the author's notes was that it was made quite evident that no condenser tube yet produced was equally suited for all conditions. If condenser tube users would bear that fact in mind when ordering tubes, they would probably save themselves much expense and annoyance. Another observation of interest to the tube maker was that out of eighteen possible cases of failures set forth by the investigator only four were attributable to any fault of the tube; the remaining fourteen lay on the shoulders of the users or the engineer.

Engineer-Lieut.-Commander G. B. Allen asked whether Dr. Bengough was absolutely satisfied that the part played by such mechanical defects as laminations, spills, &c., was no more extensive than that described in the paper. Defects of that character would usually originate in the early stages of manufacture, and it was possible that during the successive drawings, annealing and picklings the under surfaces of a surface lamination might be attacked by the pickling acid, and the salts formed squeezed into more intimate contact with the material of the tube during successive draws. Under such circumstances, it would appear that defects of that character might conceivably contain within themselves the germs of corrosive attack, which would presumably be enhanced on exposure to sea water. It was satisfactory to note that Dr. Bengough's researches had shown the relative superiority of Admiralty tubes for general purposes. The pre-oxidising treatment had much to recommend it, and some proof had been given of the beneficial effect of low-temperature annealing on the reduction of internal stress. The Admiralty had carried out some experiments with tubes treated by that method, but, owing to post-war conditions, the vessel in which those tubes were fitted had done little steaming, and no really useful observations had as yet been made. It was not quite clear why a collapsed tube should be more liable to corrosion than one which had retained its original shape. There would certainly be a greater tendency towards obstruction in collapsed tubes, and it was perhaps for that reason that such tubes suffered. He could confirm Dr. Bengough's experience that inlet deterioration was a fairly common form of corrosion, but experience in naval condensers showed that there was nothing much to choose between the top and bottom surfaces where the action was severe. He was glad to see that conditions of water flow had received so much attention, and the results of Dr. Bengough's investigations, though not exactly surprising, emphasised the difficulties with which users and designers of condensers had to contend. It was to be inferred that at speeds above 6 f/s sea water, and especially sea water contaminated with oils, broke up and formed eddies and foams, which were immediate sources of corrosion, but that at speeds of from 2–3 f/s the conditions were reasonably safe. Practically the whole of the tubes in the Navy were at one time or another exposed to conditions in which the average water speed was higher than 6 f/s, and it was not surprising that there was a certain number of failures on that account. The practical point, however, was that for naval purposes it was quite impossible to reduce the circulating water speed to such a low figure as 2–3 f/s, as that would mean doubling or trebling the tube plate area and making demands for weight and space which could not be conceded. For naval purposes, high water speed and conditions which contributed to foaming had to be accepted. He thought it might be taken for granted that in marine work all tubes would, at some time or other, be exposed to oil-contaminated waters. With regard to the design of water ends, the trouble generally occurred at the upper tubes of the first pass, where the conditions favouring agitation were often more pronounced than where the water entered the top pass. Dr. Bengough stated that leaky packing was a cause of corrosion. Leaky packing, of course, was a nuisance, but as the effect was precisely the same as that of a leaky tube, he was not clear why it should be a cause of corrosion. The experience of the Admiralty with electrolytic processes had been described to the Institute in a recent paper. Such experience as had been obtained had not been very conclusive, but there was evidence to show that the application of an externally generated current had not been successful in stopping or preventing corrosion in cases in which the water-flow conditions were unsuitable.

Dr. Harold Moore said that Dr. Bengough recommended an oxidising annealing at 350 deg. Cent., a treatment which had the effect of refining the crystalline structure. It was stated that "such treatment has but a trifling effect as regards softening the tube." A final treatment of three hours at 350 deg. Cent. ± 25 deg. was recommended for condenser tubes of 70 : 30 brass and 70 : 29 : 1 Admiralty tubes, and its inclusion in specifications was suggested. The work carried out by Mr. Beckinsale on the low-temperature annealing of Admiralty condenser tubes raised doubts whether the effect on the strength of the tube of the treatment recommended by Dr. Bengough was not greater than he appeared to believe. In recent experiments representative Admiralty condenser tubes of eight different makes were heated for three hours at 350 deg. Cent., the deviation from that temperature being less than 5 deg. Pieces of Admiralty condenser tube brass, cold-rolled to different degrees of hardness, were submitted to the same treatment, and tensile tests were made. The Brinell hardness of the tubes as supplied by the makers ranged from 135 to 165, and had been reduced by Dr. Bengough's treatment to from 78 to 92. The average Brinell hardness was 151 before and 85 after treatment. Only rarely was the Brinell hardness of condenser tubes as supplied and used found to be lower than 120, and never was it so low as 85. He would direct attention to the effect of the treatment recommended by Dr. Bengough on the yield point. In the softer material the yield point had been reduced from 25 to 11, and in the harder from 32 to 12 tons per square inch. Before specifying or adopting the treatment recommended by Dr. Bengough, both makers and users should realise that it softened condenser tubes to a marked extent, and that the mechanical properties of tubes so treated would necessarily be very different from those of the usual run of condenser tubes as used at the present time.

Mr. R. T. Rolfe raised one or two practical points. He reminded the meeting that whereas the British Engineering Standards specification for ferrules for condenser tubes and screw glands recommended a 60 : 40 alloy, Dr. Bengough did not consider that alloy the best to use in cases in which severe corrosion might be experienced. It was obvious that some of the members of the Corrosion Committee should have been members of the British Engineering Standards Committee, which drew up that specification. First of all, a 60 : 40 specification was recommended; tube makers, with all the evidence before them, said that a 70 : 30 specification was the best; Dr. Bengough suggested a 70 : 29 : 1. What was the user to do under those circumstances?

Dr. Walter Rosenhain suggested that possibly the difference between tubes which showed copper deposition on the inter-crystalline boundaries and twinning planes, and those which did not, might not be altogether a question of the initial soundness of the tube, but of the intensity of the stress present in the tube. If, therefore, the pre-oxidising treatment or low-temperature annealing was done thoroughly, it might remove small residual stresses and eliminate one cause of corrosion.

Mr. F. S. J. Pile said that Dr. Bengough would apparently allow .4 per cent. of iron. Such a content was practically unknown in practice unless it was introduced as part of the alloy, although percentages of .07, .05, and .04 were quite common. In condenser tubes which went through his hands the iron did not exceed .1 per cent., and the lead .05 to .07 per cent.

Mr. W. B. Clarke referred to difficulties which had arisen with tubes through which hydrogen had been passed for the purpose of purification. The tubes were heated externally by gas up to a temperature of about 85 deg. Cent., and afterwards showed a tendency to become porous. Catalytic copper was tried, and various makes were tested, and at last a tube consisting of alloy of nickel and copper overcame the difficulty entirely. That fact had a bearing on the percentage of nickel in the tubes.

Dr. Bengough replied at some length to the points which had been raised. With regard to the employment of .1 per cent. of iron, Sir Gerard Muntz said there were great difficulties in keeping the iron down to that amount, but Mr. Moore's paper, to be read later, gave a number of analyses of ordinary Admiralty tubes in most of which the iron was just about .1, and the Committee had in its possession a large number of tubes in which the iron was not specified at all, but in which it was practically under .1. In most of the tubes which had exceptionally long life, it was found that the iron content was .027, and in other tubes which had had a long life the same thing was found. Actually in practice the iron was kept down; it might be by accident, but if done by accident it might be clearly done systematically. Water speed was very difficult to test practically. The Committee had frequently been told what the water speeds were and had always tried to find out. There, of course, the ground was rather uncertain, because the information generally obtained with regard to water speed was simply the speed that the pump had been designed to give; in very few cases could the Committee get people actually to test the speed through the condenser, and it was necessary, therefore, to take what was really only an estimate. There was no doubt that the actual order of merit of the tubes depended, to some extent, on the water speed. On the whole, from the evidence available, the Committee had come to the conclusion that Admiralty practice was the best, and that, under certain conditions, the lead tube and the 80 : 20 nickel also gave good results. Commander Allen had raised a number of very interesting points, especially with regard to laminations and spills. Those to which reference was made as not being due to corrosion, were, of course, the ordinary laminations and spills observable on the surface of the tube. If there were hidden laminations and spills embedded in the wall of the tube, that was a different matter. With regard to the question of collapsed tubes, the Committee was not able to explain why they were slightly more corrosive than tubes which were not distorted. It was rather a complicated problem, and one on which he would prefer not to make any definite tatement. Commander Allen also raised the question of leaky packing giving rise to local corrosion. The reason was that the packing acted like any other porous body, retaining in the neighbourhood of the packing the products of corrosion, and there was consequently a tremendous attack. Mr. Moore had raised a number of very interesting questions in connection with the process of annealing recommended in the paper. The reason why a fairly hard tube was required in the condenser was that it must stand the pressure of packing at the end. It was found that the treatment recommended left the tube sufficiently strong without any very great precautions being taken. In actual practice the tube was left hard enough to stand the ordinary packing process. It had been found as a works proposition that it was not easy to get tubes regularly annealed at the lower temperatures, and that was one of the reasons why the temperature was raised. With regard to ferrules, the usual composition was that given in the standard specification, but it was found in practice sometimes that the

* No. I. appeared March 10th.

ferrules gave trouble, particularly in some Australian installations, in which, in consequence, the use of 60 : 40 material had been entirely abandoned. The Committee had found in several cases in its own experience where ferrule corrosion had taken place that a great improvement was effected by substituting ferrules of Admiralty brass for the 60 : 40. But again in many cases the 60 : 40 was quite good enough. The recommendations were based on bad conditions. With regard to the question raised as to the iron content, Mr. Pile's evidence seemed to him in direct contradiction to that of Sir Gerard Muntz, who complained that it was difficult to keep the iron down to .1, whereas Mr. Pile said it was always done. The Committee's experience was that in many cases the iron was as low as .1, but quite frequently it had experience of iron up to .25, and there were a number of instances in the literature of corrosion in which iron varied from .25 up to .5. He had been very interested in Mr. Clarke's account of the effect of .3 to .5 nickel. The Committee had no knowledge of the way in which nickel prevented the porosity of tubes to hydrogen, but the subject might be worth testing with the object of decreasing the amount of intercrystalline attack.

DIESEL ENGINE USERS' ASSOCIATION.

At a meeting of the Diesel Engine Users' Association which was held recently at the Institution of Electrical Engineers, Mr. Aubrey B. Smith read a paper on "Mechanical Lubricators." The author emphasised the fact that for internal combustion engines and air compressors the needs in regard to lubrication were not at all comparable with those of the old saturated steam engine. A brief stoppage of the oil feed to a Diesel engine or an air compressor cylinder might, he said, result in a piston seizure or abrasion of the working surfaces, and it was of the greatest importance that, having installed a mechanical lubricator to give a regular supply of oil to a given point, there should be full confidence that the lubricator employed was capable of achieving this object for long periods of time and over a wide range of load variation and temperatures. It was also essential that the lubricator should be capable of a wide range of adjustment, enabling the feeds to be cut down to a very low point indeed with every confidence. There were many designs of mechanical lubricators which, although very compact, left much to be desired with regard to accessibility of the various parts. Several models showed a measured quantity of oil going to the final discharge pump against atmospheric pressure, whereas the actual final discharge is usually performed at very much higher pressures. At the present time, suitable sight feeds were available to withstand up to 800 lb. per square inch and even higher pressures, and the author took the view that pressure on the sight feed was no disadvantage. Other forms of sight feeds showed oil that was not going to the engine, whereas what was wanted was to see the oil and the amount that was actually being fed. In some cases, especially with internal combustion engines, it was advisable also to include the time factor and to know the moment at which the oil was being fed in relation to the position of the piston or other moving part to be lubricated at that moment.

In the discussion which followed the paper, various models of mechanical lubricators were referred to and explained. The speakers generally expressed approval of the principle of sight feed under pressure. Breakages of sight-feed glasses were considered rare, and more than one speaker expressed the opinion that where accuracy was important sight feeds working under at least the same pressure as the part to which the oil was being fed would become standard practice.

NEWFOUNDLAND COAL.

The following notes on the coal resources of Newfoundland are taken from a recently issued report of the Department of Overseas Trade :—

Three areas of carboniferous strata which reach the horizon of the coal measures are present on the West Coast of Newfoundland. The most westerly of these areas is in the Codroy Valley, and occupies a basin which extends in a north-east south-west direction, a distance of approximately 8 miles. The thickness of the measures in this basin varies between 250ft. and 800ft. One coal seam with an average thickness of 12ft. has been located over a distance of 1500ft. Approximately 8000 tons of coal have been mined from this deposit, and work done has proved that the coal seam is cut off at a depth of 350ft. by a fault, and also that the seam is very much disturbed and broken up It is estimated that there are approximately 50,000 tons of coal in this deposit. Possibly, further to the north-east along the strike, continuation of this seam may be picked up, but it is doubtful whether this coal area is of economic importance. Approximately 40 miles north-east of the Codroy Valley area a basin of coal measure strata occurs, in which four coal seams have been discovered. Of these, one only is of sufficient thickness to be of economic importance. It has been proved that this seam underlies an area of approximately two-thirds of a square mile, and here it is estimated there exist one and a-half million tons of proved coal and one-half million tons of probable coal. The area is 8 miles from the railway line and approximately 23 miles from a harbour. The total area underlain by the coal measure series in this basin is approximately 20 square miles. Somewhere about 115 miles north-eastwardly from this last area a basin of coal measures strata occurs, measuring approximately 60 square miles. Extensive diamond drilling has failed to locate any coal seam of workable value. Summing up, it means that the coal measure areas of Newfoundland are underlain by about two million tons of mineable coal.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

TIMOTHY HACKWORTH AND THE LOCOMOTIVE.

Sir,—Mr. Warren is, of course, at liberty to question the correctness of any statements made in my paper to the Newcomen Society, but he has no grounds for conveying the impression that I discredit the work of George Stephenson, or would blacken his character. I have too much regard for the great work he accomplished. The position as between Stephenson and Hackworth described by me and objected to by Mr. Warren, may be expressed in the following :—

Someone—say, Mr. Warren—has a shop with a not very flourishing turnover, and offers someone else—say, myself—a share in it. Instead of joining Mr. Warren, I prefer a shop of my own, and propose starting in the same line of business and in the same town as Mr. Warren. Thus, I should become a business rival, which, quite naturally, Mr. Warren does not like. He, knowing of a vacancy in another town and of my fitness for the position, knowing also that I should like to secure the post, recommends me for it, and through his influence I succeed in obtaining it.

This is precisely what occurred. Stephenson and Hackworth are both equally concerned in the matter. The one loses a business rival; the other gains a congenial post. We may assume each is satisfied, and by no stretch of imagination can the term "discreditable" be attached to the transaction.

I welcome the opportunity Mr. Warren gives me of emphasising the remaining six points to which he takes exception. Nos. 2 and 3 may be taken together—that the locomotives failed the company and that the company all but determined to abandon locomotives for horses. What are the facts? That the engines would not make steam; that they took fourteen and fifteen hours to do the round journey of 40 miles; that they often stopped altogether. The four Stephenson engines on the railway in the first two years of working were reproductions of the Killingworth and Heiton engines constructed under Stephenson's patents and but slightly altered since 1816. Stephenson himself made the significant admission to Edward Pease in December, 1824, "that he does not see that any additions can be made to his locomotive which would entitle him to sue for a new patent"—see "Diaries of Edward Pease," page 94. The inferior work done by the locomotives was reflected elsewhere, and a very serious blow was given by the removal of three of the five engines supplied by Stephenson to the Hetton Colliery in 1822, and their replacement by reciprocating engines. Then the Newcastle and Carlisle Railway Company resolved to work their line entirely by horses. If the locomotive running on the Stockton and Darlington Railway had not proved disastrous, it is hardly likely the neighbouring company, formed of local men knowing the local circumstances, would have come to such a decision.

So badly were things going that Edward Pease and Thomas Richardson both wrote to Robert Stephenson, in South America, asking him to return or the locomotive business would be given up. Both these gentlemen were on the Railway Committee, and were also partners with Stephenson in the locomotive business. Edward Pease indeed was so "much disheartened," as Smiles puts it, that he wanted to retire from the firm.

As early as May, 1826, Joseph Pease was writing to his father about the "pecuniary embarrassment" of the railway company. At the first annual meeting in July, 1826, a load of debt was revealed. The company's banker refused advances and Edward Pease himself found the money wherewith to carry on. During the next twelve months the position was only improved by the employment of more horses. This remedy for a desperate state of affairs was highly damaging to the prospects of the locomotive, and accelerated the crisis which was only relieved by the appearance of the Royal George in November, 1827.

In regard to the relative cost of engines and horses, W. W. Tomlinson publishes two statements, widely differing, yet referring to the same period. The first by a sub-committee states that 2463 tons conveyed cost £163 with horses and only £70 with locomotives. The second, a week or two later, was in the annual report, June, 1827, saying there appears to be a saving of nearly 30 per cent. in favour of locomotive haulage. That is to say, instead of saving 2½ times the cost of horses, the Committee had whittled it down to a bare 30 per cent.—a vague, cautious report, obviously meant to reassure anxious shareholders in a concern going badly. It is unconfirmed by any figures and of no value, as separate accounts were not kept.

The success of the first engine, quoted by Mr. Warren from the *Gentleman's Magazine*, December, 1825, was published when that engine had only been running two months, is discounted by Joseph Tomlinson, and may be countered by Benjamin Thompson's reference to Stephenson's locomotive and "the miserable results of its application on the Killingworth waggonway," noted in W. W. Tomlinson's "North-Eastern Railway," page 84.

As to Mr. Warren's fourth point of criticism, Robert Stephenson certainly caused Messrs. Rastrick and Walker to insert in their report an account of the performance, not of his own engines, but of the Royal George. Here is the extract, page 17 of the report :—

"Mr. R. Stephenson has reported to us an experiment from Hackworth's engine which I prefer, because that engine has a safety-valve, which, although not quite out of the power of the engine-man, is stated by Mr. S. to have been at liberty at the time. It appears by this experiment, that the engine took forty-eight and three-quarter tons of goods 2500 yards upon a rise of ten feet in a mile, and returned down, being equal to 5000 yards upon a level, at the rate of eleven and two-tenths of a mile per hour, and that the steam was blowing off when the experiment concluded. I state the preceding as it has been given to us. Hackworth's engine is undoubtedly the most powerful that has yet been made, as the amount of tons conveyed by it, compared with other engines, proves."

Later on, they write : "Mr. Stephenson's report states the consumption of coals to have been 1 6-10th lbs. per ton per mile."

Mr. Warren's fifth point about bearing springs on the Royal George, may be passed over for the same reason given by him.

In regard to the sixth, the cause of the failure of the Sanspareil at Rainhill, I will quote from Timothy Hackworth's letter to the directors of the Liverpool and Manchester Railway, written shortly after the contest :—

"Neither in construction nor in principle was the engine deficient, but circumstances over which I could not have any control from my peculiar situation, compelled me to put that confidence in others which I found with sorrow was but too implicitly placed. . . . The whole alteration which has been made is the removal of a cylinder which failed from its defective casting."

The seventh point has to do with the first locomotive sent to Russia. I did not know Messrs. Stephenson claimed this, and as the statement I made was published some forty years ago, and possibly before that, one would think evidence to the contrary should come from elsewhere. The information at my disposal is an original drawing of the engine made at New Shildon, and dated September, 1836; also John Hackworth's passport showing he went to Russia to deliver the engine. John Hackworth has left an account of his journey. He took the engine from St. Petersburgh to Tsarskoye-Selo, where the locomotive was started in the presence of the Tzar in November, 1836. An elaborate religious ceremony was carried out, and the engine was consecrated. John Hackworth was introduced to the Tzar Nicholas, who said he had seen Blenkinsop's engines running at Middleton Colliery twenty years earlier, and "could not have conceived it possible that so radical a change could have been effected within twenty years." This does not prove that anyone else had not sent an engine out before this date. But the month of the opening ceremony is given, and John Hackworth said it was the first engine. Perhaps Mr. Warren can definitely correct me.

Finally, may I express my full agreement with Mr. Warren's desire to lay the ghosts of old animosities, and assure him that, so far as lies in my power, I am ready and anxious to assist in closing a controversy extending into the third generation?

March 13th. Robert Young.

Sir,—As a regular reader of The Engineer, I was very much interested in the article "Timothy Hackworth and the Locomotive," by Robert Young.

As a young man I lived in the neighbourhood of Bishop Auckland and Shildon, and I would say that Mr. Timothy Hackworth's name as an engineer was one to conjure with; in fact, his name will always be kept green, as being one of the cleverest engineers of his day, and certain of his inventions have not been improved on up to the present.

With regard to the Soho Engineering Works at Shildon, I have had the privilege of looking through them, though now idle, and, as an admirer of Timothy Hackworth, I always raised my hat on entering the door of those works.

I do not know whether Mr. Young is aware that, although Timothy Hackworth made his name in the locomotive world, he had the energy and ability to build other types of steam engines.

When acting in the capacity of junior draughtsman with the firm of Bolckow, Vaughan and Co. I came across a very interesting old winding engine, built by Timothy Hackworth at his Soho Works.

This engine, I believe, can still be seen at Messrs. Bolckow, Vaughan's West Auckland Colliery. There are several unique features about it which prove the genius of Timothy Hackworth. This winding engine, up to the time of the writer leaving the firm—some twenty years ago—was in good condition and working every day.

It is a single vertical type fitted with a special slide valve—probably may have been the first easing valve introduced into steam engines—it being so balanced that an ordinary workman could move the handle with his finger and thumb. This valve can be worked by hand by means of a weigh bar and lever, or actuated by a single excentric sheave, strap and rod operating on a link of special design, so that in the ordinary case of winding the brakesman uses the hand lever for "decking" purposes, and after starting the winder, by means of a smaller lever, he throws over the end of the excentric rod—which is fitted with a star-shaped die—to either side of the link motion, depending upon which direction the engine is running. The exhaust of this engine makes a most peculiar sound, almost like the bark of a dog.

From evidence received during the writer's investigations in the district from old friends, &c., he is convinced that Timothy Hackworth was the master mind in the development of the steam locomotive and also in modern stationary engines.

I give this information quite spontaneously in admiration of Timothy Hackworth as an engineer. F. Bowman.

Birtley, March 11th.

CONDENSER PERFORMANCE.

Sir,—In article No. XXIV., "Developments in Power Station Design," appearing in your issue of February 24th, particulars are given of the performance of a Worthington-Simpson surface condenser, where a vacuum of 28½in. is maintained with a supply of cooling water at 75 deg. Fah. As an examination of the temperatures points to a lower vacuum, and also as the plant installed subsequently by another maker was rated at only 28in. vacuum, it would be of interest if Messrs. Worthington-Simpson would explain the special features of their condenser which enable them to obtain such an exceptionally good result.

The duty of the condenser in question is given as 28½in. vacuum, 65,000 lb. of exhaust steam per hour, 5650 gallons per minute of cooling water at an inlet temperature of 75 deg. Fah.

Allowing for 10 per cent. wetness in the exhaust steam, the ratio of cooling water to steam would be 55 to 1, and taking the heat transferred from steam to cooling water at 1000 B.Th.U. per 1 lb. of steam, the resulting temperature of the cooling water at the condenser outlet would be 92.2 deg. Fah.

The temperature corresponding to 28½in. vacuum is about 91.8 deg. Fah., and this is already exceeded by the cooling water, without making any allowance whatever for air pressure in the condenser or for difference in temperature between the steam and water sides of the condenser tubes.

March 8th. A. A.

[It appears that the temperature of the circulating water should have been given as 15 deg. lower than that mentioned in our article, Messrs. Worthington-Simpson inform us that the plant was designed to deal with 65,000 lb. of steam per hour and to give a vacuum of 28½in. with circulating water at 60 deg., or, alternatively, to give when dealing with the same volume of steam a vacuum of 27½in., with water from cooling towers having a temperature at the inlet of the condenser of 75 deg.—Ed. The E.]

The electrification of the Melbourne railways is said to have cost four million pounds, and it is reported that another million, beyond the million now in hand, will be required to finish the work. Up to the present, about 75 miles out of the 98 route miles have been completed.

A Seven-Day Journal.

Engineering and Shipbuilding Crises.

IT can scarcely be claimed that the latest development of the engineering and shipbuilding labour troubles give promise of an early settlement. The determination of the engineering trade unions to press through the National Joint Labour Council for an inquiry under the Industrial Courts Act reflects a policy which may prevent a resumption of work for some time. At the moment of writing the result of the application for an inquiry has not been announced. The latest phase of the dispute over the method by which the war bonus of 26s. 6d. will be withdrawn in the shipbuilding industry suggests a line of compromise. It is true that the offer of the employers to divide the proposed immediate reduction of 16s. 6d. into two instalments was rejected by the men, whose representatives have put forward a counter proposal for a reduction of 10s. per week in two equal instalments. It is doubtful if this will be accepted by employers, who realise that the whole of the war bonus must be withdrawn at the earliest possible date if a revival in shipbuilding is to be brought about. The hopeful feature of the situation is that the date of the first reduction, originally fixed for Wednesday last, has been postponed, and that negotiations are still in progress.

New Waterloo Station.

WITH the formal opening by the King of the reconstructed Waterloo terminus of the London and South-Western Railway, a work for which parliamentary powers were obtained twenty years ago, and which has been in progress for many years without interruption, even during the war period, may be regarded as complete. The new station will, it is claimed, be the largest in Great Britain. The old terminus consisted, it will be recalled, of three separate stations, north, central, and south. These have now been merged in the extended station, which stands on a site of 24¼ acres, and has twenty-one platforms under one roof. Features of the design are the commodious concourse which has been provided, the laying of additional approach lines into the station, the construction of underground subways giving access to all platforms, and the excellent arrangements for the handling of the electric train services. The engineering characteristics of the design, for which the late Mr. J. W. Jacomb-Hood was responsible, have been dealt with in THE ENGINEER from time to time. The later stages of the station reconstruction have been supervised by Mr. A. W. Szlumper, the present engineer-in-chief of the company.

Lower Wages for Shipwrights.

THE hopes entertained that the dispute on the shipyard bonus may be settled have been strengthened by the announcement that shipwrights in the Bristol Channel area, who had been out on strike for three weeks on a wages issue, have returned to work. The terms of settlement are a 12½ per cent. reduction, and having regard to the stagnation in the South Wales ship-repairing industry, the men have acted in their own interests in accepting the lower rate of wages.

Retirement of M. Robert Winkler.

THOSE delegates, present at the forthcoming Rome meeting of the International Railway Association, who were at the Berne meeting of 1910, will miss one interesting personality to whom all at Berne were greatly indebted. We refer to M. Robert Winkler, who was the second Vice-president of the Swiss section of the permanent Commission, which organised the meeting, and the chairman of the local Executive Committee. Of later years, owing to our greater intimacy with continental railway matters, he has become known to many as the director-general of the International Technical Commission (l'Unité Technique), which has secured uniformity in axle loads, loading gauges, couplings, hose connections, &c., and is now engaged on trials of continuous brakes for freight trains. Owing to ill-health, M. Winkler has had to resign his appointments, including that of Director of the technical service of the Swiss Federal Railways, with which he was connected for twenty-one years. We trust that his health may improve with an increase of leisure.

New Underground Cable to Manchester.

IT is intended to bring into service almost immediately the new underground telephone cable between London and Manchester. The cable, which has been laid by the Engineering Department of the Post Office, is 183 miles long, and contains 100 pairs of wires. It is the first of the telephone trunk lines in which repeaters have been used, and one result has been to enable the weight of copper to be reduced to 40 lb. per mile compared with 300 lb. per mile in cables laid at an earlier date. A temporary relay station has been provided at Leicester, but the permanent repeater stations on the route are to be built at Fenny Stratford and Derby, and will be employed to give through connections between London, Leeds, Liverpool, and other towns, as well as Manchester. The new cable will therefore be an important link in the trunk system, and it is suggested that it ought to be possible by its use in conjunction with other circuits to give a commercial telephone service between such widely separated centres as Glasgow and Paris.

Channel Tunnel Campaign.

AN invitation has been given by Sir Arthur Fell to the French Channel Tunnel Committee to visit London in May to discuss the steps which should be taken to press on the Governments of England and France and the other interests concerned the importance of putting the tunnel works in hand. Sir Arthur, who was received a few days ago by the France-Great Britain Association, of which M. Paul Cambon is President, took advantage of that occasion to make a statement on the present situation, with special reference to public and parliamentary opinion in England. He laid special stress on the urgent need for the closest co-operation between the British and French Committees. There is a feeling, of course, that the recent trend of political events has not advanced the cause of the tunnel.

Railways and Inland Waterways.

A MEMORANDUM issued by the Federation of British Industries revives the ancient charge that the railways, through their ownership of canals, have stifled the development of waterways traffic. It is pointed out that no traffic can be transported from the centre of England without encountering railway-owned or controlled canals. For example, South Staffordshire iron traffic arises on the Birmingham Canal, and if destined for Liverpool, must pass by the Shropshire Union or Trent and Mersey Canal, whilst the Cannock coalfield has no means of water transit but the Birmingham Canal. The North Staffordshire pottery district and Burton-on-Trent have only the Trent and Mersey Canal, whilst traffic from the Warwickshire coalfield is hemmed in, except to London, by the Birmingham and Trent and Mersey Canals. All these canals are either railway-owned or controlled. In these circumstances the attitude of the railway companies towards the canals owned by them has undoubtedly, it is asserted, had an unfortunate effect upon the development of our inland waterways.

Engineering at Leipzig Fair.

THE most remarkable feature of the great Leipzig Fair is the display made in the technical section. Reports of those who have inspected these exhibits indicate a great forward movement in the design and construction of instruments of precision, tool-making machinery, and in the application of armament manufacturing resources to peace-time requirements. The Krupp interests, owing to difficulties of transport, have, concurrently with the Fair, made an exhibition in the buildings of the company of samples of semi-manufactured products required by the engineering trades. In addition, the various applications of stainless steel, cameras and projectors for the cinematograph industry, cranes, and cotton spinning machinery are illustrated in the works exhibition. The Fair as a whole reflects the strenuous effort of the German manufacturer to resume his old place in world trade.

Railways and Road Transport.

IN a memorandum which has been issued to users of road transport, the North-Western and Midland Railway group has done its best to placate opponents of its Bill. The memorandum points out that the main objection to the Bill appears to be the belief that railways are out to crush existing road transport interests, whereas they have no desire to compete unfairly with those engaged in this business, but merely claim an equal right with any other industrial organisation to develop such modern methods as are in the interest of their customers and themselves. There is certainly no intention of quoting uneconomic rates. It has been asserted, however, that although railway companies will be required to submit a schedule of standard charges for road transport to be approved by the Railway Rates Tribunal, they would still be free under the provisions of the Railways Act to quote exceptional rates below the standard rates, and that such latitude would enable them to compete unfairly with other road carriers and ultimately to extinguish such competition and thereafter increase the rates to traders. To meet this objection the North-Western and Midland group is willing to insert in the Bill a clause whereby road transport interests will have the same right as is granted to shipping and canal interests to appeal to the Minister of Transport, and thereafter to the Rates Tribunal, if it can be shown that the railway companies are charging exceptional rates which are detrimental to the public interest or inadequate, having regard to the services in respect of which such rates are charged. This group is also willing to keep special accounts of the road transport business in order to make it clear to the trading community that the rates charged are such as will produce a net revenue sufficient to earn a profit on the capital employed in operating road services. The railway companies concerned are as anxious as their competitors that the road services shall be self-supporting. The hope is expressed that the definite pledges now given will remove any apprehension as to the completeness of the safeguards outlined in the Bill, which it is felt arose in a large measure from a lack of appreciation of the intentions of the railway companies to make such safeguards effective.

Mauretania as Oil Burner.

A DISTINGUISHED company was present on board the Mauretania when she left the Tyne on Saturday last for Southampton to take her place in the Atlantic service after the conversion to the burning of oil fuel. This work has been carried out by the builders of the vessel, Swan, Hunter and Wigham Richardson, Limited, the Wallsend-Howden system of oil burning having been installed. The coal bunkers, extending the full length of the four boiler-rooms on each side of the vessel, have been subdivided and arranged for the carriage of about 5350 tons of oil fuel. The liquid fuel is first drawn from the storage tank to the settling tank and thence through steam heaters to the boilers. When the ship was coal-fired the engineering staff numbered 446; as an oil-burning ship the number will be reduced to 175. Concurrently with the conversion to oil burning, the state-rooms and passenger accommodation throughout the ship have been overhauled, and many improvements effected, including the provision of a parquet floor for dancing in the centre of the lounge. The performance of this high-speed Atlantic liner under oil fuel will be watched with extreme interest, and it is not unlikely that her previous speed records will be broken.

New Graving Dock at Swansea.

ACCORDING to a statement made at this week's meeting of the Swansea Harbour Trust, tenders for the new graving dock will be received within the next few days. In its first form the dock will be 522ft. long and 75ft. wide, but provision has been made in the choice of the site for an ultimate length of 710ft., and it is anticipated that the growth of the oil trade, in connection with the Anglo-Persian developments at Llan d'Arcy, will call for the construction of a second large dry dock, the site for which has already been reserved. The provision of the first of the new graving docks marks the beginning of a large scheme of port improvements involving an expenditure of £500,000.

Tube Railway Extensions.

THE Government has given its approval to the scheme for a modified programme of tube railway extensions and improvements, and it is understood that work will be put in hand during the next few weeks. It will be recalled that the scheme originally put forward included the enlargement of the City and South London Railway tunnels to standard tube railway dimensions, the linking up of that railway by a short section of new tunnel with the Hampstead and Highgate Railway at Camden Town, and the extension of the Central London system to form a connection with the London and South-Western electric lines at Richmond. It was anticipated before the decision of the Underground Railways' management was announced that these were the two projects which would be carried out with the capital amounting to £5,000,000, for the interest on which the Government has been asked to give a guarantee, and that the extension of the Hampstead Railway from Golders Green to Edgware would be deferred. It is understood, however, that the Edgware extension will be included in the modified scheme. A good deal of surprise has been occasioned by this announcement, as it was imagined that the traffic prospects of the connection with the South-Western Railway would have induced the Underground management to proceed with that scheme rather than with the new Edgware railway, on which traffic will have to be developed in connection with the housing scheme.

New Technical Institute for Hull.

IT is announced that Mr. T. R. Ferens, whose benefactions to Hull have been numerous, is about to add to them by a gift of about £10,000 for the purchase of a site for a new technical college. This addition to the educational facilities of the town has been needed for some time past, and it is appropriate that the gift should be made in the year when, after a long interval, the British Association, whose visits serve to stimulate interest in scientific education, should be re-visiting the city for its annual meeting.

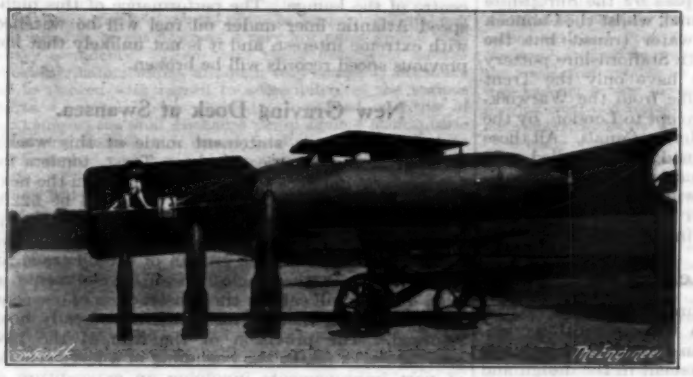
The Effect of Bomb Attack on Warships.

IN the course of last summer a series of highly important experiments was carried out in the United States with the object of determining the effect of bomb attack on warships. These tests were conducted on a somewhat elaborate scale and every effort was made to invest them with reality. The targets, which included one Dreadnought battleship of comparatively recent design, two old battleships, one light cruiser, and several destroyers and submarines, were mostly anchored, thus presenting stationary targets; but one of them, viz., the battleship Iowa, was under wireless control and was subjected to attack while under way at moderate speeds and on a varying course. In accordance with their usual policy in such matters, the American authorities concerned have permitted the publication of fairly detailed accounts of the experiments. Moreover, the official report of the Joint Army and Navy Board which was appointed to investigate the results of the bombing tests has been published, apparently in full; and, representing as it does an authoritative verdict on the possibilities of a weapon which many believe will revolutionise and all admit must seriously affect the future of naval warfare, this document deserves careful consideration. Space does not permit of more than a few extracts, but the following passages are of special interest:—

"The number of dummy bombs which actually hit the target during the experiments with the ex-Iowa was a very small percentage of those dropped. Other experiments, however, showed that it is not necessary to make direct hits on naval vessels to put them out of action, or to sink them, provided the bombs drop sufficiently close to the vessel, and the explosive charge is sufficiently large to produce a mine effect of such proportions as to destroy the water-tight integrity of the vessel beyond the control of its *personnel* and pumps. The effective target for the bomb being, therefore, greater than the deck area of the target vessel, the percentage of effective bombs would be greater than the percentage of actual hits. . . . Aircraft carrying high-capacity high-explosive bombs of sufficient size have adequate offensive power to sink or seriously damage any naval vessel at present constructed, provided such projectiles can be placed in the water close alongside the vessel. Furthermore, it will be difficult, if not impossible, to build any type of vessel of sufficient strength to withstand the destructive force that can be obtained with the largest bombs that aeroplanes may be able to carry from shore bases or sheltered harbours. So far as is known, no planes large enough to carry a bomb effective against a major ship have been flown from, or landed on, an aeroplane carrier at sea. It is probable, however, that future development will make such operations practicable. . . . The most serious effect of bombs is the mining effect when such bombs explode close alongside and below the surface of the water."

The above findings will doubtless be hailed by the anti-battleship school of criticism as further proof that the great armoured leviathan is obsolete and no longer worthy of perpetuation. In this article, however, we do not propose to re-open this controversy, but merely to give a brief description of the principal results of the tests in question and some account of the formidable bombs which are now being developed in the United States and, doubtless, in other countries as well. The most suggestive and, at the same time, most significant feature of the American experiments was the sinking of the ex-German battleship Ostfriesland. She was a vessel of 22,800 tons, completed in 1911, and embodying the special German system of subdivision which war experience showed to be remarkably effective in minimising the results of explosions below the water line. After sustaining a number of deck hits from heavy bombs which caused only superficial damage that would not have impaired the fighting efficiency of the ship, the Ostfriesland was finally sent to the bottom by two bombs, each weighing one ton, which were dropped, not on the ship itself, but close alongside, and exploded several feet below the surface. When the tremendous upheaval of water had subsided the vessel was seen to be settling down, and soon afterwards she foundered. It was obvious that the two explosions had blown in a very large area of the underbody and exerted sufficient force to rupture the anti-torpedo bulkhead which stood at some distance from the shell plating. In other words, one or both of these bombs—for it is not altogether certain that both exploded in the immediate vicinity of the ship—had caused considerably more damage than would have resulted from the detonation of a torpedo or a mine, for experiments which had been made in Germany before the war showed that the subdivision in vessels of the "Ostfriesland" type was such as to enable them to keep afloat after the explosion of two torpedoes. Thus, even if we assume that both the bombs exerted their full force against the target, it is evident that these weapons represent a most formidable menace to ships even of the largest dimensions, and, as the Joint Army and Navy Board observes in its report, they have adequate offensive power to sink or seriously damage any naval vessel at present constructed, provided they can be placed in the water alongside and brought to explosion at the requisite depth.

Whether the two bombs that sunk the Ostfriesland would have proved equally deadly against a ship which was fitted with bulge protection, and which, furthermore, had on board a crew that was well trained in the use of the pumps and flooding arrangements, is a debatable point; but if it be argued that the target was not of the very latest design, the airmen might retort that neither were the weapons they used against it. As we have said, the heaviest bomb dropped against the Ostfriesland weighed approximately one ton, but the newest pattern of "demolition bomb" now being supplied to the American air service weighs about two tons—or, to be precise, 4300 lb. Although this tremendous engine of destruction has yet to be tested against a floating target, the trials which have been made with it on land leave no doubt as to its formidable powers. Through the courtesy of the *Scientific American* we are able to publish herewith a view of this bomb, and also on page 299 two views of the damage caused by direct hits with 2000 lb. bombs on the deck of the old battleship Alabama. Alongside the view of the bomb are shown, for comparison in sizes, examples of a 25 lb., a 50 lb., and a 100 lb. bomb.



4000 LB. DEMOLITION, AND SMALLER BOMBS

According to Major W. A. Borden, who is in charge of the Aircraft Armament Division of the Office of the Chief of Ordnance, United States Army, the largest bomb manufactured in America during the war weighed 1100 lb. When it was decided to use the ex-German warships in the capacity of targets, it was realised that a unique opportunity was thus presented for obtaining practical experience as to the value of heavy bombs in naval warfare. Steps were accordingly taken at once to manufacture a bomb weighing 2000 lb., and several of this type were completed in time to be used in the Alabama test. Although the results were eminently satisfactory, it was appreciated that bombs of still larger size might be required to attack modern capital ships or land targets, and it was therefore decided to produce a 4000 lb. bomb. "Of all bombs," writes Major Borden, "those of the demolition type have the widest field of application, and are therefore of great military importance. They carry a large amount of high explosive, the charge being from 50 to 60 per cent. of the total weight of the bomb, and when they strike a terrific blast is produced by the detonation of the charge, which, within its destructive range, causes tremendous damage."* In designing bombs of this type the essential object is to give the body a maximum explosive capacity without sacrificing the strength that will enable it to withstand impact against the target. When buildings are to be attacked it is very desirable that the bomb shall not explode until it has passed through the roof and all the floors, for when that happens and detonation occurs on the ground floor or basement the destruction of the building as a whole is far more complete.

To a certain extent this principle applies also to bombs designed for use against naval targets, for it is obvious that if several decks are pierced and detonation takes place well down in the hull, the effect will be greater than that of a burst on the upper deck. Judging from the Ostfriesland result, however, the most effective point at which a bomb used against a warship can explode is close alongside the vessel and at a depth of anything from 10ft. to 40ft.

Our illustration shows the 4000 lb. demolition bomb as completed. It is 13½ft. in length and 24in. in diameter. The body consists of a steel cylinder, closed at each end by a steel casing, tapering to a point at the nose, while at the rear end there is a slightly convex plate carrying a rib to which the fins or wind vanes are attached. These latter are formed of four large sheet steel fins riveted to a cone of the same metal and braced by steel tubes. Two fuses are fitted to the bomb, one in the nose and the other in the rear part of the container, both being adjustable either for instantaneous or delay action. The usual safety device is fitted in the shape of a wind wheel, which, operating as the bomb falls, releases the firing pins, so that, on impact, the primers in the fuse will be struck and the bomb brought to detonation. The total weight of the complete bomb is 4300 lb., of which the T.N.T. charge accounts for 2000 lb. Major Borden states that one week was required for filling each of these bombs, which probably contained a larger quantity of high explosive than had ever previously been packed into one receptacle. The T.N.T. was melted and poured into the container in increments, time being allowed for each layer to solidify before the next was added. When the last layer had been poured the charge took more than four days to cool. The first of these bombs was taken up by a Handley Page machine and dropped on to a field from a height of 4000ft. The pilot of the machine states that when the bomb was released the aeroplane shot up about 20ft., but "the effect was no greater than that from a bad bump often encountered in flying." The fuse of this particular bomb was adjusted for short delay action and the missile had penetrated 10ft. into the ground before detonation took place. It blew out an immense crater 65ft. in diameter and 19ft. deep, the displacement of earth being equivalent to 1046 cubic yards. What the effect of a direct hit on a ship would have been must be left to the imagination, but some idea of it is conveyed by our illustration of the battleship Alabama, after being attacked by two bombs less than half the weight of this gigantic missile.

Full details of the Alabama experiment are not available. It appears, however, that at least one 2000 lb. bomb scored a direct hit on the forward part of the ship, which it completely wrecked, the cage mast and both funnels being blown over and the deck plating of the forecastle badly torn and buckled. There is no doubt that a single hit such as this would have sufficed to disable the ship, even if it did not destroy her entirely. It will be noticed that, what with the buckling of the forecastle deck and the wreckage of the mast and bridgework, the field of fire from the forward turret is greatly restricted, and even if the guns remained in action they could only be trained through a very limited arc on the beam. The Alabama was sunk in the same way as the Ostfriesland had been—that is to say, by a heavy bomb detonating below the surface close alongside. Without desiring to exaggerate the importance of these American tests, we think it will be admitted that they have furnished conclusive evidence that bomb attack from aircraft has already become a serious menace to the largest warships. There is, of course, a world of difference between experiments such as these, when the attack is carried out under the most favourable conditions and the target is anchored and defenceless, and similar operations conducted under war conditions, when a vessel about to be attacked by aircraft would doubtless be steaming at full speed, altering course at brief intervals to confuse the aim and making vigorous use of her anti-aircraft armament. What the American tests have demonstrated beyond cavil is that a single heavy bomb dropped in the right place is capable of placing a battleship of the largest dimensions *hors de combat*. With this fact definitely established efforts will probably be made to effect such improvement in bomb sights as will render bomb dropping at high altitudes sufficiently accurate to ensure a reasonable percentage of hits. That considerable progress has already been achieved in this direction is well known, but in view of the great military importance of the subject, future developments will no doubt be treated with the same secrecy which has always been observed by the various Governments with regard to current progress in naval gunnery.

* *Scientific American*, February, 1922.

The Development of Counterbalancing in British Locomotive Practice.

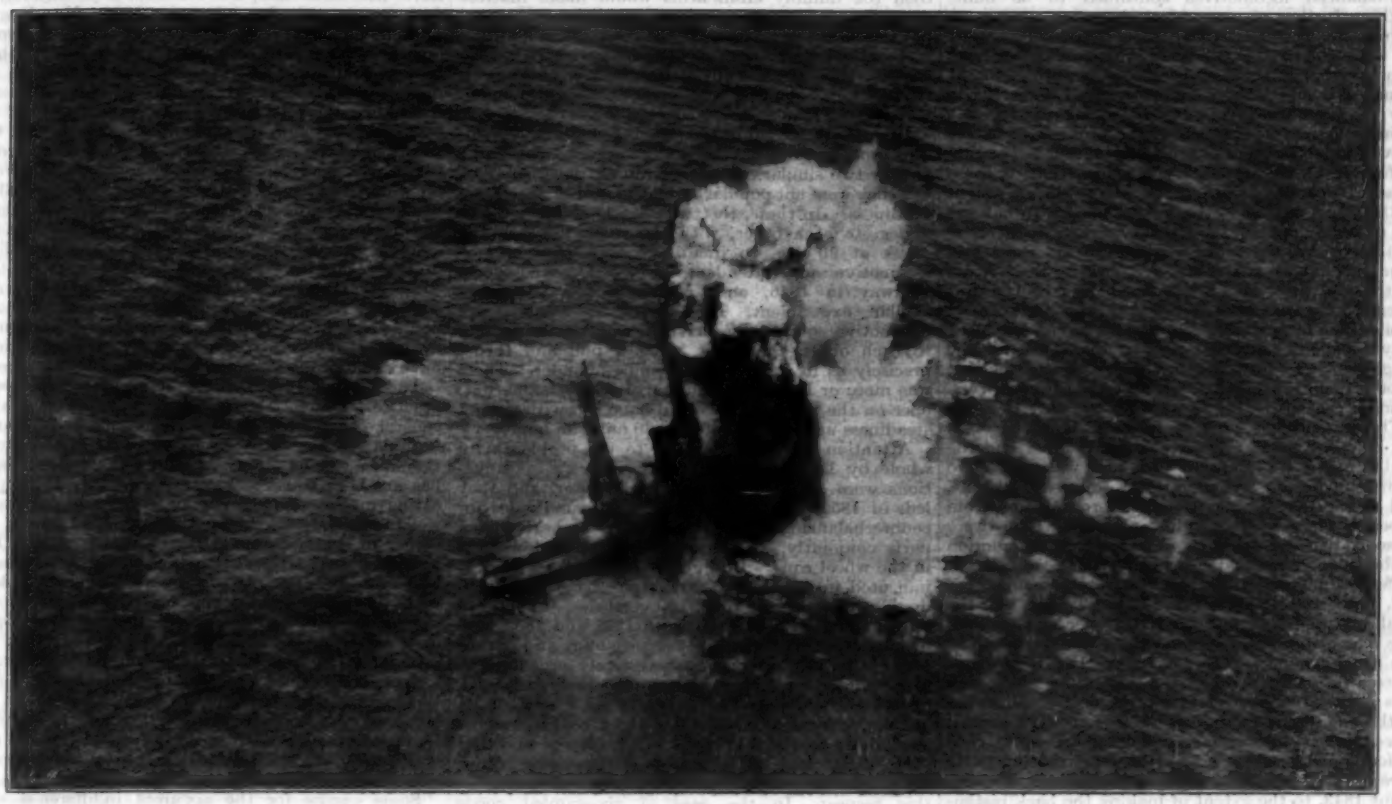
By F. W. BREWER, A. Inst. Loco. E.

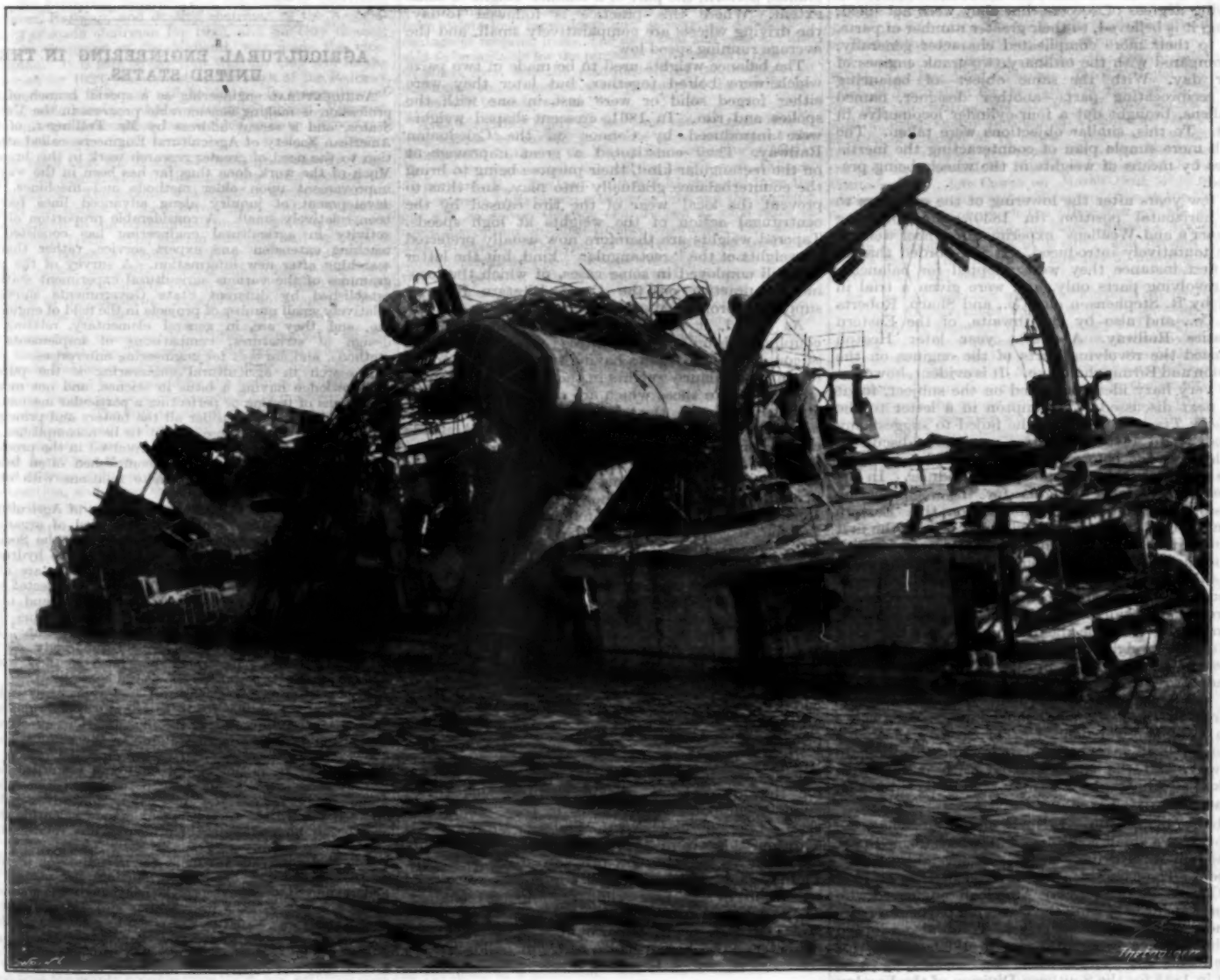
THE counterbalancing of the reciprocating and revolving masses of locomotives has always presented an interesting problem, but while the necessity for neutralising the disturbing forces due to those masses became evident as soon as speeds increased, yet it remained but imperfectly understood for many years. So imperfect was the knowledge of the subject that even when counterbalancing became fairly general the balance weights were not infrequently inserted in the wrong quadrant of the wheels. In some instances, at first, only the reciprocating parts were allowed for; in others, only the revolving parts. The balance weights were often too heavy.

With one exception, the earliest locomotives were not balanced at all. This exception was the Agenoria, of Foster, Rastrick and Co., a four-coupled engine

TEST BOMB ATTACK ON THE U.S. BATTLESHIP ALABAMA

(For description see opposite page.)





of the "grasshopper" type, completed for the Shutt End Railway in 1829, and now preserved in the South Kensington Museum. The use of counterweights fixed in the rims of the main driving wheels of this engine appears to have taught no lesson, as non-balanced locomotives continued to be built. Nothing further of a practical character appears to have been done until 1834, when balancing engaged the attention of J. G. Bodmer, a Swiss engineer, who came over to England and followed his profession at Manchester and Bolton. Apparently, Bodmer early saw the advisability of fully balancing the reciprocating masses. This phase of the problem has since proved to be the more difficult one (except in the case of four-crank engines), for the reason that, if these masses be counterpoised in full, the resultant weight in the wheel, added to the weight needed to balance the revolving masses, sets up very serious disturbance in the vertical direction, tending to lift the wheel from the rail when the crank is passing the bottom centre, and to cause a "hammer-blow" on the rails when the crank is moving over the top centre. While, therefore, the revolving parts can and must be fully balanced, only one-half to two-thirds of the weight of the reciprocating parts is the amount usually counterbalanced at the present time in two-cylinder engines.

The locomotives running in 1834, however, were not balanced at all; consequently, Bodmer had the field of research to himself. His plan was to use two horizontal inside cylinders with opposed pistons, and in the first designs the piston-rods issued from opposite ends of the cylinder, where they were attached to the crossheads. The reciprocating motion of the front piston and crosshead—that nearest to the buffer beam—was imparted to a return connecting-rod, supported by a vibrating link. To this link the small end of the connecting-rod proper was secured. The rear piston and its connections were arranged in the usual manner. The four connecting-rods drove on to a four-throw crank axle, which had the crank pins disposed opposite one another on the same side of the engine, as in the case of the modern normal four-cylinder locomotive. The engine was thus perfectly balanced so far as the reciprocating parts were concerned. The design was modified by Bodmer about 1843, to the extent of making the back piston-rod hollow, and passing the front one through it, both rods, therefore, issuing from the same end of each cylinder. His locomotives were tried on the South-Eastern, and London, Brighton and South Coast lines; and on at least one railway in the North, with varying degrees of success, but they were not liked, owing, it is believed, to their greater number of parts, and to their more complicated character generally, as compared with the ordinary two-crank engines of their day. With the same object—of balancing the reciprocating parts—another designer, named Weallens, brought out a four-cylinder locomotive in 1836. To this, similar objections were taken. The much more simple plan of counteracting the inertia forces by means of weights in the wheels being preferred.

A few years after the lowering of the cylinders to the horizontal position (in 1830), and following Bodmer's and Weallens' experiments, wheel weights were tentatively introduced. It is recorded that in the first instance they were adopted for balancing the revolving parts only, and were given a trial in 1837 by R. Stephenson and Co., and Sharp, Roberts and Co., and also by Braithwaite, of the Eastern Counties Railway. About a year later Heaton balanced the revolving parts of the engines on the London and Birmingham line. It is evident, however, that very hazy ideas prevailed on the subject, for it was next discussed by Crampton in a letter to the *Railway Times* in 1842, but he failed to suggest any remedy. In 1845 the matter was again discussed, on this occasion before the Gauge Commissioners, by both Robert Stephenson and J. G. Bodmer. In the same year, balance weights for the reciprocating masses were tried by Fernihough on the Eastern Counties Railway, and it is said that he was the first engineer to employ weights in the wheels for this particular purpose. For counterbalancing the same parts, Heaton devised a novel plan in 1847. It consisted in having a supplementary or dummy connecting-rod on each side, one end of which rod was attached to an outside crank on the driving axle, and the other to a dummy weight working in guides under the footplate by the side of the fire-box. The weight corresponded with the piston, &c., and as the extra crank and the driving crank proper were on opposite centres on the same side, the reciprocating masses were completely balanced. This contrivance was in use for some years on the London and Birmingham Railway, and the engines fitted with it ran with marked steadiness, but, as may readily be supposed, it was never extensively used.

About 1845, Edward Bury employed what, no doubt, was a small counterweight, which formed part of the hub of the driving wheel. The weight was fan-shaped. The same idea was revived in 1896 or 1897 by George S. Strong, an American engineer, who adopted it for balancing the revolving parts of a four-cylinder compound locomotive. Webb also adopted it, though in a different form, in 1899. Bury, for some of his larger single-wheel engines, such as those built in 1848 for the Southern Division of the London and North-Western Railway, employed large weights at the rims of the wheels, extending over five spokes.

The practice of some makers at that time was the provision of duplicate crank-arms for six-coupled engines with inside cylinders. If the coupling-rod crank pins were at 180 deg. to the inside cranks, then the dummy crank arms would make matters worse, but it is now impossible to establish the actual position of the main cranks. The feature in question is, however, worth noting. It may be added, nevertheless, that Heaton initiated extended crank-arms for partially balancing the engines of the London and Birmingham Railway in 1838-9.

In order to get rid of the swaying couple, Stephensons brought out a three-cylinder locomotive in 1846.* One or two similar engines were built down to 1853, but they were not popular, on account of their relative costliness. In these, the two outside cranks were at 0 deg. to each other, with the single-throw inside crank at 90 deg. to them. Sinclair, who became locomotive superintendent of the Great Eastern Railway in 1856, once carried out a somewhat similar experiment. He altered a two-cylinder locomotive so that the driving cranks were at zero to each other, the effect being a pull and thrust precisely as in the case of a single cylinder. There was more or less trouble in starting the engine, but, once on the move, it is said to have ran with perfect steadiness up to speeds of over 60 miles an hour.

Attention was next devoted to the problem as a whole by David Kinnear Clark. Clark's investigations were of a very thorough character, and they led, in 1852, to the formulation of sound rules for counterbalancing the reciprocating and revolving parts conjointly, and entirely by means of weights in the wheel rims. In a general sense, these rules—indicated in a previous paragraph—have held good down to the present time. Nevertheless, in spite of all that had been done between 1837 and 1852, and in spite, moreover, of the proved accuracy and advantage of Clark's method, a comparatively large number of locomotives remained either improperly balanced, or wholly unbalanced. In fact, here and there, engines continued to be built without counterweights at all down to about 1864, though it may be said that such cases had been gradually becoming rarer. Passenger engines are more especially referred to in this respect. In the case of six-coupled goods locomotives with inside cylinders, counterweights were often omitted, and even nowadays a number of such engines are running without them, as the outside cranks and rods, being opposite the main cranks, perform the part of a balance-weight to some extent. Where this practice is followed to-day, the driving wheels are comparatively small, and the average running speed low.

The balance-weights used to be made in two parts which were bolted together, but later they were either forged solid or were cast in one with the spokes and rim. In 1861, crescent-shaped weights were introduced by Connor on the Caledonian Railway. They constituted a great improvement on the rectangular kind, their purpose being to bring the counterbalance gradually into play, and thus to prevent the local wear of the tire caused by the centrifugal action of the weights at high speeds. Tapered weights are therefore now usually preferred to weights of the "rectangular" kind, but the latter are still employed in some cases, of which the locomotive practice on the Great Western Railway supplies a prominent example.

As stated, it has been customary to place the coupling-rods on opposite centres to the inside cranks of coupled-wheel engines having two inside cylinders, for smaller balance-weights in the wheels can then be employed than those which are requisite for outside cylinder engines. Occasionally, such practice has been departed from by putting both inside and outside cranks on corresponding centres. There is some difficulty in determining when this method was first actually tried, but it was certainly a feature of Stroudley's practice on the Highland Railway in 1866, and was subsequently followed by him on the London, Brighton and South Coast Railway. It was also given a trial by McDonnell on the Great Southern and Western Railway (Ireland), and by Dean on the Great Western. A few years ago, Mr. A. J. Hill, the present chief mechanical engineer of the Great Eastern Railway, adopted it. The advantages claimed for it lie in the reduced wear and tear of the axle-boxes and hornblocks, big-end brasses and coupling-rod bushes, together with a reduction in the stresses imposed on the connecting-rods. A heavier counterweight is necessary, but, on the other hand, all the stresses on the one side are in accord instead of being in opposition.

The use of prolonged crank arms to act as counterbalances was introduced by Mr. F. W. Webb in 1889 for the low-pressure motion parts of his three-cylinder compound locomotives of the "Teutonic" class, London and North-Western Railway. In addition, there were "rectangular" balance-weights in the rims of the low-pressure driving wheels. Eight years later, balanced inside cranks were used by Webb in his four-cylinder compound engines. The latter were further counterbalanced by means of large circular wheel hubs or bosses, 2ft. 9in. in diameter. The bosses had a series of hollow spaces cast in them at the back, and into a certain number of these spaces lead was poured, thus forming a balance for the outside rods, so that no weights were needed in the wheel rims for the revolving parts. Speaking generally, self-balanced crank axles have not been adopted for ordinary locomotives with inside cylinders, but in 1903, Mr. Dugald Drummond instituted a departure in this respect on the London and South-Western, by fitting them to four-coupled bogie express engines, in which the balancing was so far complete that weights in the wheels were omitted. Such axles are usually of the built-up type, and are therefore expensive, and this seems to be the reason why they have not been more frequently used for two-cylinder engines. There is no doubt, however, that they afford an excellent means for counteracting the disturbing forces due to the reciprocating and revolving parts of inside cylinder locomotives, since the forces are neutralised in the planes in which they are set up. Another engineer, Mr. George Hughes, on the Lancashire and Yorkshire Railway, is using balanced cranks in some double-end inside-cylinder passenger tank engines, but these, unlike Mr. Drummond's express engines, have small graduated weights in the driving wheels.

This brings the subject down to present-day practice. Opinions differ a little, but there is a fairly general agreement—based primarily on Clark's formula—as to the extent to which counterbalancing should be carried out. According to this formula, it has not been usual to balance the whole of reciprocating masses of two-cylinder engines by means of weights in the wheels, but this was done during the *régime* of the late Mr. T. Hurry Riches on the Taff Vale Railway. The balancing of these masses is best attained, of course, by the use of four cylinders, with the crank centres opposite each other on the same side. In such cases the inside revolving parts may be counter-weighted in the wheel rims, or, preferably, by the employment of balanced crank webs. The former practice obtains on the Great Western Railway and Great Central Railway, and the latter on the London and North-Western Railway, Lancashire and Yorkshire Railway, and London and South-Western Railway, for the heavy four-cylinder non-compound locomotives in use on these roads.

Some excuse for the apparent indifference with which counterbalancing was at one time treated may perhaps be found in the fact that the motion parts were comparatively light; but, then, on the other hand, the weights in the wheels would have been correspondingly small.

* Isaac Dodds and Owen patented a three-cylinder locomotive in 1839.—ED. THE E.

AGRICULTURAL ENGINEERING IN THE UNITED STATES.

AGRICULTURAL engineering as a special branch of the profession is making considerable progress in the United States, and a recent address by Mr. Trallinger, of the American Society of Agricultural Engineers, called attention to the need of greater research work in this branch. Much of the work done thus far has been in the way of improvement upon older methods and machines, the development of inquiry along advanced lines having been relatively small. A considerable proportion of the activity in agricultural engineering has consisted of teaching extension and expert service, rather than a searching after new information. A survey of the programmes of the various agricultural experiment stations established by different State Governments shows a relatively small number of projects in the field of engineering, and they are, in general elementary, relating to design of structures, comparisons of implements or methods, and surveys for engineering enterprises.

Research in agricultural engineering is the pursuit of knowledge having a basis in science, and not merely the means of testing or perfecting a particular mechanical device. It aims to consider all the factors and principles involved and the purpose sought to be accomplished, as well as the mechanical ingenuity involved in the product. Study of the purpose to be accomplished often brings engineering research into intimate relations with other branches of agricultural science.

The formation of the American Society of Agricultural Engineers was in recognition of this need of organised means for advancement. For several years the Society has had a Research Committee. Some of the hydraulic formulas used in irrigation and land drainage are illustrations of the results of its work, which is reflected also in certain developments of farm machinery and other appliances. This Committee has suggested some fifty specific lines for investigation and experiment. For example, there is a profitable field for study of the theoretical basis of ploughing, and such a study would involve a grasp of several agricultural specialities.

In the training of agricultural engineers stress is laid naturally upon ability to do things, to apply rules and to be resourceful in meeting specific conditions effectively. Less attention is given to training in the acquisition of knowledge which is new, in questioning the reason for a process or in raising doubt as to an empirical fact. But there is a great difference between experience and sound judgment, on the one hand, and investigation directed toward the establishment of new scientific facts or a better understanding of principles and relationships on the other hand.

The provision thus far made for investigation at most of the agricultural experiment stations established by Federal and State agencies is relatively small, the engineers being engaged largely in teaching and extension work and in designing structures or plans to meet the needs of applicants. But if this special branch of engineering is to grow, it must be through research which is serious and severe, and the department must not be exclusively for teaching and service or assistance, and must not be restricted wholly to practical affairs.

Railway Matters.

THE Queensland Railway Department intends to use coal produced at the State colliery when the railway line to the coalfields is opened. It is estimated that by the use of this fuel the Department will effect a saving of about £40,000 a year.

THE Railway Rates Tribunal and the Rates Advisory Committee have now moved to 2, Clement's Inn, Strand, London, W.C. 2. The Advisory Committee is now holding a public inquiry with regard to the classification of merchandise. The Railway Rates Tribunal will, at a later date, fix the standard charges to be attached to the classification determined by the Advisory Committee.

SPEAKING at the annual meeting of the Underground Electric Railways Company on the 9th instant, Lord Ashfield remarked that there was a prospect of much reduced expenditure by the Underground during the present year. But traffic was falling too. In the first seven weeks of this year compared with last year passengers had fallen in numbers by about 4,050,000, and traffic receipts by about £189,000. There was just a chance that the outlook was brightening.

TASMANIA is likely soon to be sending out orders for material for the construction of locomotives. Large railway works are in course of erection at Launceston, and the Railway Commissioner has expressed the hope that it will not be necessary for the Island State to import any further engines from the mainland when the present contracts expire. He considers that the cost of the requisite tools would be defrayed by the saving which would be effected by building the first half-dozen engines locally.

THE London, Brighton and South Coast Company is concerned over the reduction in the number of first-class passengers, the indications being that that class is the one most seriously affected by the increase in fares. The company cannot very well move independently in the matter, as all railway companies are concerned. Apparently, similar results are being experienced by the latter, and it is probable that the question of some diminution of first-class fares will have early consideration by the general managers.

THE Negotiating Committee of the railway companies met representatives of the National Union of Railwaymen and the Associated Society of Locomotive Engineers and Firemen at Westminster on the 1st inst. to consider the application of the companies to revise wages and hours. Methods of applying the proposals to various grades were discussed, but no decision was reached, and an adjournment was made to enable more detailed information to be given, and also to expedite the settlement of the grading of signalmen and other outstanding matters.

AT a recent meeting of the Railway Companies Association, Sir Frederick Banbury, the chairman of the Great Northern Railway, and deputy chairman of the Association, was made chairman for 1922, and Sir Guy Granet, the new chairman of the Midland, was made the vice-chairman. It is safe to say that thus Sir Guy will be the chairman for 1923, when most of the work of the Railway Amalgamation Tribunal will be done. In recognition of the valuable services of the retiring chairman, Viscount Churchill, the Association has decided to have his portrait painted in oils.

THE form that the North Staffordshire Railway Company's war memorial is to take has now been decided by the directors. The scheme will combine the commemoration of the names of their heroic dead with a desirable improvement to the booking-hall and the station platform at Stoke-on-Trent. The station entrance will be opened out into a spacious booking-hall by the removal of the present rather unsightly booking-office, and a wide and handsome flying arch will give a more dignified and free entrance to the platform. It is proposed to spend about £1000 on the war memorial portion of the scheme.

ANSWERING a question, Mr. Hilton Young said, on the 13th inst., that the Treasury, on the recommendation of the Trade Facilities Advisory Committee, has agreed to guarantee a loan to be raised by the London Underground Railways for the purpose of extending and improving their tube railways. The full details of the arrangement have not yet been agreed, and it would not be desirable to make an incomplete statement. The company estimates that 15,000 to 20,000 men will be provided with work for a period of from eighteen months to two years on the actual construction, and when the work is completed permanent employment will be provided for a considerable number.

ACCORDING to the *Sydney Morning Herald*, a development in the system of autogeneous welding has been made at the Eveleigh railway workshops. Mr. E. E. Lucy, the chief mechanical engineer of the New South Wales Government Railways, has designed the underframe of a locomotive tender which is being constructed by means of that process, which, it is said, has not before been applied to constructional work of the same character. The method employed is to connect the parts by mortices and tenons, and then to weld them, thus obviating to a great extent the use of rivets. The Railway Department intends to build a number of tenders by the aid of electric arc welding, and it is estimated that a considerable economy in cost, as well as in time, will be effected. The strength of the frame, it is stated, will also be increased.

IT is the opinion of Colonel Pringle that the collision of December 19th at Auckland Junction, Leamside, on the North-Eastern Railway, was primarily due to the failure of the signalman and secondarily to the failure of a shunter. The former opened the points and lowered the signal for some empty carriages to leave a siding. A passenger train passed off the up line on to the Durham branch at the same time that the carriages left the siding, and so, it being dark at the time, in addition to the traffic being somewhat disorganised for reasons that need not be explained, the signalman did not notice the departure of the empty carriages. The shunter also failed to protect the carriages by exhibiting a red light, and thus, when an up express was offered the signalman, the latter failed to see that the empty coaches were there, and assumed that they had not left the siding. The collision resulted.

Notes and Memoranda.

THE value of the output of minerals in New South Wales during the year 1921 was £14,018,048, which was an increase of £2,607,186 as compared with the previous year. The number of persons employed was 29,701, showing an increase of 538 over the previous year.

IN the fourth issue of the *Fuel Economy Review* published by the Federation of British Industries, there is an interesting description of the power plant in an East Anglian timber mill. Wood refuse is consumed in gas producers, and the gas is used in engines driving dynamos. The engines have a total capacity of 870 horse-power, and the exhaust gases are used to raise steam for timber drying. Besides driving the mill, the station supplies power and lighting in the surrounding district, and the generating costs are 1.351d. per kilowatt-hour.

IT is announced that a new device has been developed by the United States Navy which makes it possible readily to measure exceptional ocean depths and for navigators to take soundings as easily and as frequently as they wish. The device, which is described as simple, employs a sound apparatus similar to that developed for submarine detection during the war, the principle being the creation of a sound on board ship and the measuring of the time between this sound and the return of its echo from the bottom of the sea. The time interval, it is said, can be measured to within one one-thousandth of a second.

THE general problem of decreasing the sulphur in metallurgical coke demands that some knowledge should be obtained with reference to how the sulphur in coke occurs. Unfortunately, this is not known, although several futile attempts have been made to determine in what form the sulphur occurs in coke. A new method of attack has been outlined by the Bureau of Mines which promises to give much more information on this subject. This method involves the passage of hydrogen through the hot coke, thereby giving a means for measuring the dissociation pressure of the carbon-sulphur combination. Application of the phase rule to these results will indicate whether the sulphur is present as a compound, a solid solution or absorbed. The results so far obtained by the Bureau of Mines seem to indicate the presence of a compound but further work will be required to substantiate this and study its properties.

THE establishment of a big iron and steel industry in South Africa is, according to a statement made in a recent issue of the *Cape Argus*, in contemplation. A representative of an influential group of ironmasters in England has recently carried out investigations regarding the natural resources in iron ores of the country, with the result, it is said, that the tests of ores available for production of iron and steel have been eminently successful, and that large reserves capable of carrying on the industry for fifty or sixty years have been proved. The ore that was submitted to test is described as being entirely free from deleterious ingredients and as carrying a high percentage of metallic iron. The local coal and coke are also said to be suitable for the purpose. Not only is it proposed to smelt iron, but the manufacture of tar, sulphate of ammonia, benzol and other by-products of the distillation of coal will be undertaken.

A LABORATORY study of the time rate of reduction of iron oxides by carbon monoxide is under way at the Minneapolis Station of the United States Bureau of Mines. The reducing gas employed will be 35 per cent. CO and 65 per cent. N_2. The iron oxide will be obtained from the higher grade Lake Superior shipping ores and the reducing gas will be driven through the ore bed at such rates of speed as obtain in blast-furnace operation, *i.e.*, about 25ft. a second. The rate of the reaction is known to depend primarily upon the gas velocity and the size of the ore particles. To a lesser extent, the reaction will depend upon the temperature and the composition of the reducing gas. It is only when conditions of the experiment approximate blast-furnace conditions that the laboratory results will have a technical application. Previous workers in this field have invariably used extremely low gas velocities, and have used carbon monoxide without dilution in nitrogen. The greater number of them have also sought to obtain equilibrium conditions and not reaction rates. This investigation is undertaken by the Bureau of Mines to supply the need of data which may be of practical use.

A LECTURE on "The Present Position and Future Prospects of Industrial Electrical Heating" was given at the University of Sheffield on March 13th, by Mr. J. G. Pearce, B.Sc., A.M.I.E.E., of the Metropolitan-Vickers Electrical Company, Limited, to the Sheffield Gas Consumers' Association. Mr. D. Flather presided. Sheffield is one of the largest consumers of gas for industrial purposes in the United Kingdom. After indicating the influence on electrical heating development of the nickel-chromium resistance alloys, the lecturer considered the relative positions of gas and electricity for heating purposes, and stated that, for a given amount of heat required by a consumer, a modern super-power station used less fuel than was required in any other form of fuel conversion. The recent improvements which have been made in the manufacture of high-speed and high-capacity turbines, together with a projected scheme for linking-up power stations, would enable electrical energy to be procured at rates much more favourable than had hitherto been possible. For precision heating, electricity was unapproached by any other heating agent—it was rapid, and practically any desired temperature could be obtained. Electrical heating did not distort the material, and spoiled work was almost entirely eliminated. Heaters occupied a minimum of floor space and were less detrimental to workers than other forms of furnace. It was particularly important that those who were considering the installation of electrical heaters should not compare merely the cost of electrical energy with the cost of gas at the power station and gasworks respectively, as the efficiencies of distribution and application had to be considered. In electrical heating, no heat was wasted through warming up the air used for combustion, and radiation losses could be cut down to a minimum. The lecturer then described a number of modern heating appliances.

Miscellanea.

IT is reported that as a result of the growing lack of business in the Swiss watch and clock trade, several large works have already entirely transformed their machinery. One important works at La Chaux-de-Fonds has decided to take up the manufacture of locomotives, and has produced a model which is described as being very satisfactory.

IT was stated by Mr. Bridgeman (Secretary for Mines), on March 6th, that the only producing oil well in this country was that put into operation on behalf of the Government at Hardstoft, in Derbyshire. The production for the six months ended December 31st, 1921, amounted to 78 tons. The evidence so far obtained had not been sufficiently conclusive to admit of an opinion as to the commercial possibilities of oil boring in this country. The Government had abandoned its intention of introducing legislation to give the Crown further powers than those it already possessed under the Petroleum Production Act.

AT a meeting held in Birmingham on March 3rd, the opinion was unanimously endorsed that all interested in non-ferrous metals, whether manufacturers or consumers, should support the Non-ferrous Metal Research Association. A scheme to found temporary fellowships, to enable university post-graduates to remain at college for an extra year, especially for research work, was favourably regarded. It was pointed out that there were still many fields open for the employment of non-ferrous metals, and that experimental investigation was rendered doubly important by the appearance of non-corrodible iron and steel alloys.

THE monthly tables of the National Federation of Iron and Steel Manufacturers show that the production of pig iron in February amounted to 300,100 tons, a figure higher than has been reached in any month since the coal stoppage began, but less by 163,500 tons than the production of the corresponding month last year. The furnaces in blast at the end of February numbered 101, compared with 90 at the end of January and 193 at the end of February, 1920. Of the production of pig iron in February, 101,800 tons were hematite, 90,100 tons basic, 69,000 tons foundry and 20,000 tons forge. The production of steel ingots and castings in February amounted to 415,000 tons, compared with 327,500 tons in January and 483,500 tons in February, 1921.

THE Orient liner Orontes, a liner on the Australian trade of rather more than 9000 tons, has, it is reported, been sold to a syndicate which is converting her into an exhibition ship at once. While the British Industry is definitely held up for a year in the hope that trade prospects will improve, the Orontes is scheduled to sail on May 1st. She should have completed her forty thousand miles cruise by next January. She is to be re-named British Trader. Comparatively few alterations will be made, the present extensive first and second-class accommodation being used for the stallholders as living places and offices, while the steerage quarters and big 'tween decks and holds will be fitted up with nearly 300 stalls. Particular attention is to be paid to the machinery and motor trades.

A NEW motor lifeboat, named the Alfred and Clara Heath, has just been completed by the Royal National Lifeboat Institution for its station at Brixham in Devon. She is a self-righting lifeboat, 40ft. by 10ft. 6in., is fitted with a Tylor engine developing 45 horse-power, and is capable of a speed of 7½ knots. The vessel, which was built out of a legacy generously left to the Institution by the late Mr. Alfred John Heath, of Putney, by J. Samuel White and Co., left Cowes on March 15th to go to her station by sea under her own power. She is the first of five sister boats, of which the other four are all nearing completion, their station being Selsey, Sussex; Appledore, Devon; Bembridge, Isle of Wight; and Sennen Cove, Land's End. The Institution now has 32 motor lifeboats in its fleet of 241 boats.

AT a recent luncheon under the auspices of the British Electrical Development Association, Mr. Arthur Neal, Parliamentary Secretary of the Ministry of Transport, said nothing would be wanting on the part of the Government to do everything possible to make clear the path of progress. The Electricity Act of 1919, establishing the Electricity Commissioners, was a step in the direction of mapping out the whole country into suitable divisions. That plan was working with much greater goodwill than anyone could have foretold. With regard to electrification of railways, he said the principal companies which would ultimately form the Southern Group were formulating plans and schemes for electrification. He was anxious that electrification should take place, in order to give work in the electrical industry.

IT is reported from Melbourne that Messrs. C. Ruwolt and Co. are constructing at their works in Melbourne what is said to be the largest dredger yet built for the tin industry. The pontoons are approximately 155ft. in length, and the dredger is provided with ninety buckets, each of 9 cubic feet capacity. The vessel, which is for the South Taiping Company, Federated Malay States, is designed to handle up to 100,000 cubic yards of tin-dredging material per month, and its displacement will be 1200 tons. The whole of the boilers, engines and equipment is being built in Australia, but the steel plates are imported material. The dredger, which is being assembled in Melbourne, will, when completed, be dissembled and the parts marked and forwarded to destination, where 400 Chinese labourers will be employed in the re-assembling.

AT the second annual meeting of the British Non-ferrous Metals Research Association, held at Birmingham on March 3rd, Mr. T. Bolton, who presided, surveyed the activities and progress of the Association, which has now over 100 member firms, and stated that a number of important investigations were being conducted by the Association in various laboratories. He emphasised the fact that division of labour is as important among brain workers as among hand workers, and co-operative research was the best and most economical method. He referred particularly to the proposal of the Association to establish University Fellowships for post-graduate research. Amongst the subsequent speakers were Sir George Goodwin, Dr. Rosenhain, Sir Henry Fowler Sir Frank Heath, Sir Gerard Muntz, and Sir Richard Threlfall.

COAL AND ASH-HANDLING PLANT AT BARGOED ELECTRIC GENERATING STATION

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(*For description see page 290*)

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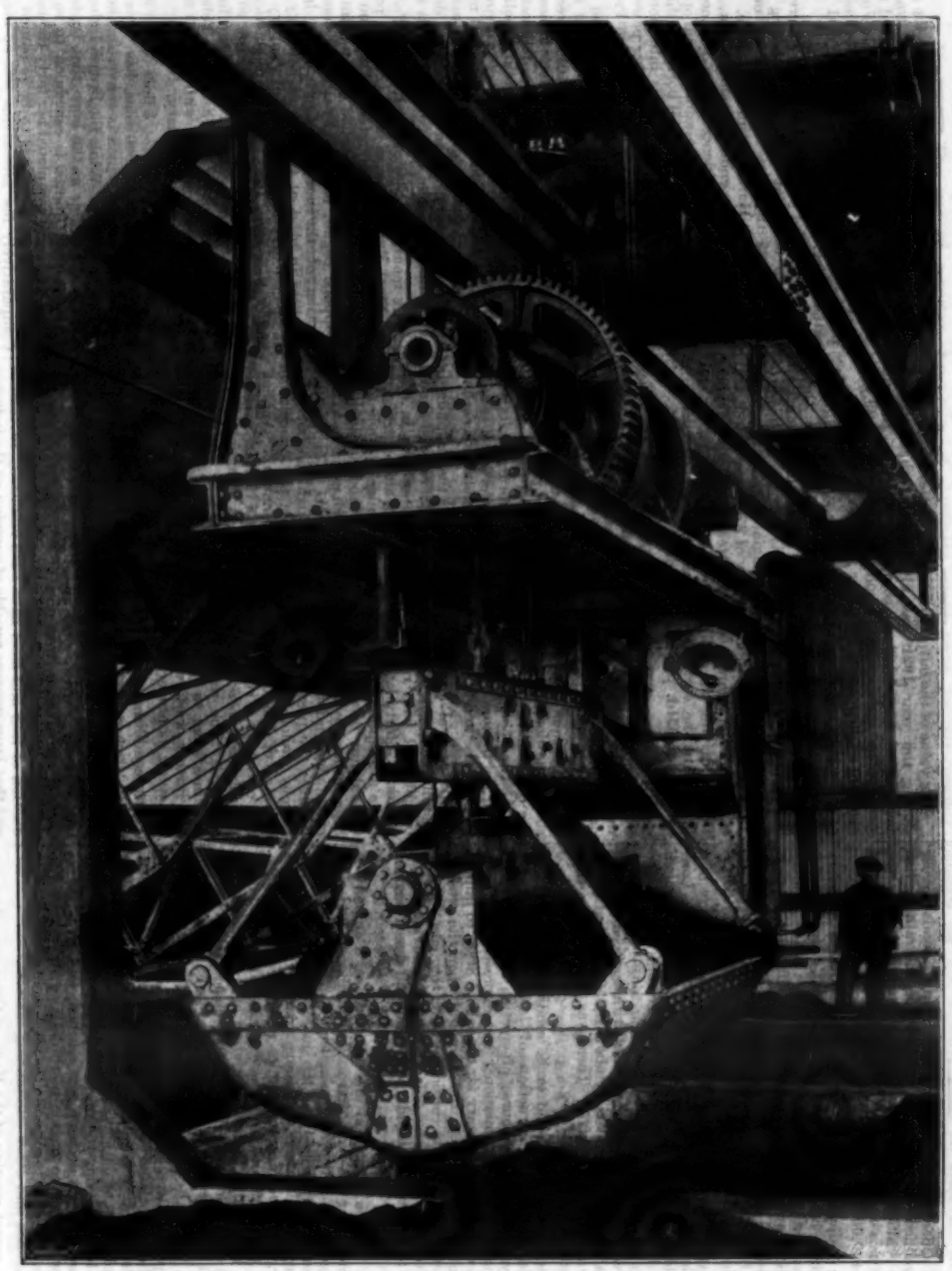

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THE ENGINEER.

MARCH 17, 1922.

The Lock-Out.

Although the issues which led up to the lock-out in the engineering trades are of long standing and have been discussed for many months past by the representatives of the employers and of the trades unions, acrimony has been avoided. Even up to the last moment both parties recognised that the other was fighting cleanly for a principle, and there was no bitterness or bad temper. If that attitude can be maintained there is some hope that an early end to the struggle may be reached. If it cannot be, or if the chance of it be deliberately destroyed by those who use ill-will as a political weapon, then we may have to face a long and severe fight. It is held by some that the Amalgamated Engineering Union is in such a bad financial position that it cannot long bear the strain. To prophesy a short and sharp struggle on that account would be unwise. Indeed, we see more danger in the depletion of the funds of the Union than hope that with their exhaustion the men will give in. The elements of discord are still abroad in the land, and they will find it easier to recruit empty stomachs than full ones. Moreover, the employers have no desire to see the union destroyed. Indeed, it is the last thing they wish. If they observe with regret that the A.E.U. has not all the merits of the old Amalgamated Society of Engineers, they are, yet, ready to recognise that modern conditions render the existence of trades unions convenient, if not indispensable, and they would rather the A.E.U. which they know remained than that another union or other unions which they do not know arose from its ashes. What the employers want is not the destruction of the union, but the curtailment of the powers which it secured under the stress of war and which inhibit the rapid and complete recovery of the engineering industries of the country. They hold that were they able to control their workshops in their own way they could get more trade; the union, on its side, asserts that if it be allowed to control certain elements of workshop economics it can reduce unemployment. Both sides, we believe, are perfectly honest. But a principle is at stake, and as a compromise on principles is rarely possible and never permanently satisfactory, the fight must be fought to the end.

Let us dismiss from our minds for the moment the contingent issues—Communism and so on—which the struggle may present and consider only the main elements. The union believes that by reducing the output per man it can bring about the employment of a greater number. It is with that object that it desires to limit the number of hours of overtime, for it contends that every hour above the statutory forty-seven that one man works he takes from another. We need not waste time over the plea that the union is anxious about the shortening of the leisure of its men. It knows well enough that a personal matter of that kind may be left to its members themselves. What it seeks is not more leisure but more employment. Not only does out-of-work benefit bear very heavily upon its funds, but it is humanely touched by the distress that follows upon lack of work and wages. We have Mr. Clynes' word for it that Labour does not believe that, had it the power, it could solve that never-ending problem in an over-populated country; but Labour does believe that the methods it advocates would alleviate the ill. Certain as we are that it is following an economic error, we cannot deny that—the hot-heads excepted—it is honest in its purpose and its belief. In the pursuit of its principles it seeks continuously for a shorter working day, the removal of all incentives—such as piece work and premium bonus plans—to exceptional efforts, and it often insists on the employment of more men than are required by the nature of the work. The principle of one man one machine is familiar to all. It is perhaps not so well known that in other trades the same policy is pushed to extremes. A couple of examples occurs to us. Two men can handle an acetylene or electric welding apparatus, but the trades union requirements involve the employment in some cases of no less than six, of whom four remain idle whilst drawing full pay. Again, in the unloading of ships by mechanical means, the rule is held that the mechanical appliance may be employed provided that it does not displace labour. As a consequence, many men have to be paid full rates though they do scarcely a stroke of work. The principle throughout is the same. Virtually what it comes to is this: "Pay all the men and you may increase your output; but you shall not have the same output for a lesser number of men." In that principle we must seek the key to many trades union actions.

The principle for which the employers are fighting is the reverse of that outlined above. The works owner is not less anxious than the men to see his shops full; he is not less touched and troubled by the distress which follows unemployment; but the remedy that he offers is diametrically opposed to that of the unions. "Give me," he says, "a free hand to manage my factory in my own way; let me employ cheap labour when it will suit me as well as dear; let me pay by the piece or bonus; let me employ one man to look after several machines; let me use no more labour on any operation than it really requires, and I can undersell my foreign competitors and bring to the country trade that now passes it by because the price is too high or the time of delivery too long." That is the employers' case. Let us admit freely and at once that he has never taken sufficient pains to prove it. No one who has studied the history of economics doubts that it is sound, but such palpable evidence as is required to convince the working man is never advanced. Steady propaganda and continual persistence on plain, rudimentary and incontestable facts are required. To hark back to the development of the textile trade may satisfy the historian, it will not convince the mechanic. Facts nearer to his own time, nearer to his own work, are needed. He has before him, from his own speakers, the apparently incontrovertible dictum that there is so much work to go round, and the more men engaged on it the less the amount of unemployment. That dictum must be countered. Employers must show and keep on showing in the simplest and bluntest way that the premise is wrong; that there is not, in fact, a certain limited amount of work to go round, but that the amount of work continually increases with the ability to execute it. It is not even sufficient to prove, as they can readily prove, that orders are lost by high costs and long deliveries. They must go further. Negative evidence is not as convincing as positive evidence. Let them show that the number of orders is increased, and that employment is extended, by the reduction of costs and the decrease of time and there will be some chance of the men listening to them and believing there is something in their policy.

It will be seen that with two principles so radically opposed in the balance there is an opening for a bitter and prolonged struggle. Yet there are good reasons for believing that it will be neither one nor the other. Let us glance at these reasons. In the forefront we place the fact that the Execu-

tive of the A.E.U. agreed to the clauses upon which the dispute now turns. It went further, for on the ballot paper it recommended their acceptance. Unfortunately, there are reasons for suspecting that in some cases that recommendation never reached the voters, who, in consequence, were left in the dark as to the wishes and actions of their Executive. In the second place, we have to remember that the actual adverse majority was no more than 12 per cent. of the total membership of the A.E.U. In the third place, we have the well-known fact that it was only the failure to find a a good reason for doing so that prevented the Executive of the A.E.U. from holding a second ballot. Had it taken its courage in both hands and called for a new ballot, with or without reason, the original vote would probably have been reversed. Finally, we have the state of affairs. The men are not blind to the indications of an upward tendency in trade; they are not blind to the fact that the union is nearing bankruptcy; they know that those locked out cannot draw the "dole." These things must influence them. The majority of them desire to get back to work; they do not want to prolong their enforced holiday; and if they can see their way to do it they will throw the recalcitrants to the wind and return to the shops. Furthermore, if the union holds out long it will lose nearly all the recruits it gained during the war period, of whom many, as soon as they have exhausted out-of-work benefit equivalent to their few years of contributions, will leave. These are favourable signs, but we would not have it believed that we are rejoicing over the tactical weakness of the union. Far from it. We are convinced that the bulk of British workpeople would rather leave the management of factories to the managers. They do not want to be troubled with "managerial functions," as the lapsing of the shop stewards' committees proves. These steady, peace-loving members form the backbone of the union, and it is not they who would be defeated but the turbulent minority that fosters discontent and leads them into trouble. Could we but have secret voting; could we but see a ballot conducted with as much correctness as a parliamentary election, true trades unionism would come by its own again, and the employers would be the first to rejoice.

It has been said that the employers have taken advantage of the time to precipitate this dispute. That is not true. The trouble has been imminent for eighteen months, and it is purely coincidental that it has come to a head at this moment. It was no more planned by the Employers' Federation than by Mr. Brownlie. But that it should have come now is a matter for congratulation rather than the reverse. Trade is so bad that the cessation of what there was makes little difference. Had trade been good, the sudden rise of unemployment would have been serious indeed. It has also been said that if a compromise is not found the men will return to work in a surly mood and with the intention to make trouble again on the slightest pretext. That also is not true. It is only a small portion of the members who rejected the agreement reached by the employers and the Executive of the A.E.U. Those members will always be potentially fractious. The greater number of the men—by far the greater number—are ready to accept the terms and return to work. It is, however, unfortunate that three other unions are now involved in the dispute—the Engineering and Shipbuilding Trades Federation, the National Union of Foundry Workers, and the National Federation of General Workers. The members of these three unions are being now asked to vote for the acceptance or rejection of "the Three Clauses." Of these clauses the first carries all the weight. It runs: "The trade union shall not interfere with the right of the employers to exercise managerial functions in their establishments, and the Federations shall not interfere with the proper functions of the trade union." The ballot papers are to be returned by March 23rd. In these conditions voting must take place whilst the lock-out is in progress, and to keep all acerbity out of the balloting will be humanly impossible. Whilst it is difficult to see how this predicament could have been avoided, one cannot but regret it. The fractious sections will turn the circumstances to their advantage and induce many men to vote against their better instincts. An effort will, also, be made to drag the Government into the dispute. So far it has held aloof, and we trust sincerely it will continue to do so. But should it be unable to resist the pressure, we suggest to it that its first step should be to arrange for a ballot of all the unions concerned on the single question of managerial functions, and that that ballot should be taken by independent officers and with the same secrecy and care as a parliamentary ballot.

Reduction of the Navy.

A statement by the First Lord of the Admiralty explanatory of the Navy Estimates for 1922–23, was published on Monday in advance of the Estimates themselves, which are shortly to be laid before Parliament. This document shows that very substantial reductions are to be made in naval expenditure during the coming financial year as a result of the Limitation Treaty entered into at Washington. It is appropriate that Lord Lee of Fareham, to whose efforts the success of the Conference was due in great measure, should be sponsor for the first Navy Estimates that reflect the decisions reached at that gathering. Some twelve months ago, shortly after taking up his appointment as First Lord, he expressed the hope that "as a result of frank and friendly discussion with the principal Naval Powers" it would be possible "to avoid anything approaching to competitive building, either now or in the future." As he observes in his present statement, "that anticipation has now been largely realised, and a new era of hope ushered in for an impoverished and war-weary world."

The reduction to be effected in naval disbursements during 1922–23 is shown by the following comparison with the Estimates for the current fiscal year:—

	Gross. £	Net. £
1921–22	91,554,869	82,479,000
1922–23	68,950,000 (approx.) ..	64,883,700
Reduction ..	£22,604,869	£17,595,300

The "One-Power Standard" of naval strength, which has been adopted by the Government, connotes the maintenance of a Navy not inferior in strength to that of any other Power. According to Lord Lee, the Admiralty has not only framed its requirements in conformity with the new standard, but has gone further in accepting drastic economies, and consequent risks, which could only be justified on the assumption that the British Fleet will not be engaged in any great war for many years to come." The Admiralty adds that on purely naval grounds such an assumption could not be justified, but as both the financial and the international situation call for an exceptional response, it has made it, realising, however, that in this matter a very grave responsibility is imposed upon it. The principal economies which it is proposed to effect may be summarised as follows:—

(*a*) The scrapping of twelve capital ships, in addition to the eight recently sold for breaking up, and the maintenance of only fifteen in full commission, as compared with thirty-eight in March, 1914.

(*b*) Further reductions in the destroyer flotillas of the Atlantic Fleet, involving the maintenance in full commission of only forty boats. One of the present flotillas is to be reduced to two-fifths complement, and twenty-three destroyers of the Local Defence Flotillas are to be placed in reserve.

(*c*) Of the eighty-five submarines now on the Navy List, twenty-seven are to be scrapped. These latter, it is understood, comprise all the remaining "K" and "E" boats and most of the "R" class.

(*d*) The abolition of two of the Home Commands, viz., Coast of Scotland and Western Approaches.

(*e*) A reduction of the *personnel* of the fleet by more than 20,000 officers and men. In consequence of this very drastic cut it will be necessary to diminish the ship's company of each vessel of the Atlantic Fleet by 15.7 per cent. The present complement per ship is higher than the pre-war establishment, war experience having shown the desirability of increasing the number of officers and men borne in each vessel.

(*f*) The discharge of over 10,000 men from the Royal Dockyards, and a drastic reduction of civil staffs at the Admiralty and other establishments. Rosyth is the dockyard principally affected by this decision. In future it will be reserved for the docking of such ships as, by reason of their dimensions, cannot be docked at the southern yards, and for certain refitting work in connection with these vessels. Chatham and Pembroke are to be retained as Royal Yards—the first because it has small docks and storehouse accommodation with which the fleet cannot well dispense, and the second because its abolition would deprive the inhabitants of the town of Pembroke of their chief source of livelihood and thus create so much local distress that any direct saving in national expenditure would be more than neutralised by the necessity of granting relief. The Gibraltar yard is to be reduced, the annual saving at this establishment being estimated at £58,000. As the Admiralty points out these dockyard economies have been determined upon solely in the interests of national economy, and without regard to the requirements of the fleet. The result will be to delay and restrict a great deal of important ship construction and reconstruction, as well as repair and refitting work on vessels of the fleet. It is obvious that the plan of so enlarging the main slips at Portsmouth and Devonport as to enable those yards to undertake the building of post-war capital ships has been postponed indefinitely.

For the past month or two it had been persistently rumoured that the two new battleships which the Naval Limitation Treaty authorises this country to build would not be proceeded with. Fortunately, these rumours are now disproved, the First Lord stating that the vessels in question will be laid down early in 1923. The delay is probably due to the necessity of recasting their designs in harmony with the displacement limit of 35,000 tons specified by the Treaty. It is no longer a secret that the four battle-cruisers authorised last year, but subsequently cancelled, were to have had a displacement of about 47,000 tons. In place, therefore, of the 188,000 tons of new construction contemplated last year, we are to build only 70,000 tons. Had the four battle-cruisers been proceeded with the coming year's vote for contract shipbuilding would have amounted to £10,557,800, whereas it is actually limited to £300,000. This is, of course, the largest individual item of reduction directly attributable to the Washington Conference. Vote 9—Naval Armaments—shows a cut of £1,837,200 as compared with the last Estimates. This money is to be saved by deferring the overhaul and reconditioning of surplus stocks of ammunition, by keeping smaller reserves of mines and depth charges, and by delaying the issue of new armour-piercing shell. Economies of this kind would be inadmissible were the international situation less promising, but as it is they cannot be said to entail serious risk. Expenditure on naval works is to be reduced by £1,573,600, the Admiralty having arranged to proceed only with those undertakings the completion of which is either essential or would involve less outlay than the liquidation of the contracts. A further large saving is to be made in regard to oil fuel and coal, economies under this head reaching the impressive total of £5,386,500. It will mean cutting down the fleet's fuel allowance to the lowest possible limit, the laying up of several Royal Fleet Auxiliary ships normally employed on fleet fuelling duty, and the restriction by £500,000 of the development in 1922–23 of the Navy's oil fuel depôts at various bases abroad. The Lords of the Admiralty have not taken this step "without considerable anxiety, which will, they believe, be shared by all who realise the extent to which the mobility of the chief units of the British fleet is restricted under existing conditions, owing to the absence of the necessary oil-fuelling bases."

The Votes for Education and Scientific Services show between them a reduction of £122,000. The Admiralty—wisely, as we think—has declined to accept the drastic cut in expenditure on scientific and research work that the Geddes Report recommended. Such a measure would, it feels, "be inexcusable at a time when we are forced to rely more and more on the hope that the Navy will make up in quality of *personnel* and superiority of technique for the lead that has been surrendered in respect of *matériel*. Of all the lessons of the war, none stood out more clearly than the importance, and the previous inadequacy, of scientific research, and the Admiralty is convinced that the measures which it has taken are not more than sufficient to maintain research and experiment on a sound and at the same time very moderate and economical basis."

The foregoing review of the First Lord's statement shows that the Admiralty has made a determined attempt to cut down expenditure on the naval service. It is clear from his observations that further economies can be effected only at the cost of sacrificing efficiency to such an extent that the Navy would be no longer competent to carry out its duties in a national emergency.

NEW MOTOR FUEL FROM SURPLUS WINE.

It is reported from Cape Town that 10 million gallons of surplus wine in South Africa are to be converted into motor fuel, and that for that purpose a large factory has been erected at Paarl, which gave its first yield early in this year. The stagnation of the wine industry last year, and the proposal to let the considerable surplus go waste, gave the idea to a Natal Senator attending the session of Parliament that the wine might be converted to industrial purposes. He transmitted his idea to the directors of the Natal Cane By-Products Company, who are conducting a factory at Merebank, outside Durban, mainly for the manufacture of the motor fuel natalite, methylated spirit, ether, chloroform and other productions from alcoholic spirit.

The Natal company realised the possibilities of utilising the Cape wines, and negotiations with the Western Province Wine-growers' Association resulted in the formation of the South African Motor Fuel Supply Company, Limited, and that company speedily commenced operations, and now the factory is in full operation.

The wine arrives in leaguers and hogsheads, and is dumped into three storage tanks, each holding 30,000 gallons. From the receiving tanks it is drawn up to a supply tank, and thence to a still, which is said to be capable of turning out 3000 gallons per day.

From the answer given on the 22nd ult. by the Under-Secretary of State for War, it appears that an order for 100 locomotives was placed, with Cabinet authority, at Woolwich in October, 1919, by the Ministry of Munitions before the Arsenal reverted to the War Office, the object being to afford relief to unemployment. No arrangements were made for the disposal of the engines when built, but they were of a design suitable for use on British railways. So far as is known, no estimate of cost was prepared when the order was placed, but the locomotives have been built during a period of high prices, both for material and labour, and the cost is now estimated at £1,600,000. They have been reported to the Disposal and Liquidation Commission for sale. Answering a supplementary question, Sir R. Sanders said that he believed that none of the locomotives had been purchased or placed.

British Industries Fair at Birmingham.

No. III.*

We continue below our description of some of the exhibits at the British Industries Fair held at Castle Bromwich, Birmingham, from February 27th to March 10th.

Drop Forgings.

The Association of Drop Forgers and Stampers had an imposing stand opposite the entrance to the building at the end of the long corridor already mentioned. The first feature to meet the eye was a large drawing of a motor car with, lying in front of it, a collection of forgings used in its production. There were streamers of ribbon connecting the actual parts with the drawing, and the whole exhibit showed very forcibly to what a large extent drop forgings enter into the construction of such a machine. There was a large variety of other classes of forgings on the stand, ranging from scissor blanks and small gun parts up to engine crank shafts, besides examples of forgings in yellow metal and copper.

Among the firms belonging to the Association which had exhibits at the Fair there are Alldays and Onions, Limited, of Small Heath, Birmingham; Armstrong, Stevens and Son, Limited, Walsall-road, Willenhall, Staffs; W. Bain and Co., Limited, Coatbridge; W. Beardmore and Co., Limited, Glasgow; Brett's Stamping Company, Limited, Coventry; Clayton Wagons, Limited, Lincoln; the Coventry Stamping Company, Limited, Coventry; Head, Wrightson and Co., Limited, Thornaby-on-Tees; P. and W. McLellan, Limited, Glasgow; G. D. Peters and Co., Limited, Slough; the Rotherham Forge and Rolling Mills Company, Limited, Rotherham; the Smethwick Stamping Company, Limited, Smethwick; the Tees Side Bridge and Engineering Works, Limited, Middlesbrough.

Automatic Lighting Sets.

One of the most fascinating petrol-driven lighting plants at the Fair was exhibited by the Austin Motor Company, Limited, of Northfield, Birmingham, at work lighting that company's stands. It was of 2 kilowatts capacity and was fully loaded, while there was another little ¼-kilowatt plant running. The peculiar fascination in these sets lies in the remarkable extent to which they have been made independent of attention. Apart from an occasional cleaning, the only requirements they have are supplies of fuel and oil; otherwise they go on running or stop running, entirely automatically, according to the demands made upon them. Moreover, the total expenditure of energy which is necessary to maintain this automatic control is only about 1 watt. In these new machines the switchboard has been entirely eliminated and the controlling apparatus is enclosed in an extension of the commutator bracket of the machine itself. When the battery is discharged to a predetermined extent the plant automatically starts and current for the lights is taken from auxiliary brush gear, the voltage being regulated by auxiliary poles in the machine itself. This compensation is, of course, necessary on account of the increase in voltage across the battery when on charge, the idea being to keep the voltage at the lights as nearly constant as possible. Light can be taken in excess of the output of the machine while the plant is running, as it combines the characteristics of an automatic reversible booster. Under some conditions the voltage at the lights may be higher than that of the battery. In order to meet a certain amount of prejudice among some possible users as to the merits of automatic plants, two small switches are provided, the one for controlling the automatic starting, the other the automatic stopping, so that the user may operate the plant either as a hand-controlled set, *i.e.*, hand starting and hand stopping, but self regulating—semi-automatic, *i.e.*, self starting or self stopping and self regulating—fully automatic, *i.e.*, self starting, self stopping and self regulating. A belt-driven automatic dynamo intended for those who already have power available and therefore do not require to purchase an engine was also shown on this stand.

Switchgear.

On the stand of J. H. Tucker and Co., Limited, King's-road, Tyseley, Birmingham, a great feature was made this year of a new range of small moderate-priced accumulator switchboards specially designed for use with modern small private plants using low-voltage metal filament lamps. All kinds of modifications in the make-up and connections of the boards, to suit different systems, have been thought out and standardised, and the boards can be supplied with S.P. or D.P. switches and one or two ammeters. Four examples were shown and for exhibition purposes were arranged by hinging to swing out from the wall to permit of an inspection of the back connections. This range is standardised in 15 and 25 ampère sizes and for 25, 50, 75, and 100 volts. Larger boards are standardised in 15, 25, 50, 75, and 100-ampère sizes and for 25, 50, 75, 100, and 150 volts. Loose switchboard components were shown, illustrating the "N.K." switches in ranges from 75 to 1200 ampères, the "O.K." switches and "H" fuses in ranges from 15 to 100 ampères, and the "F" handle type power fuses from 75 to 1200 ampères. These switches are made in single, double, and triple pole, tandem and parallel coupled type, and in single and double-throw pattern. Voltmeter, shunt regulating, battery regulating, and automatic battery switches, are among the other forms of switchboard details made by this firm.

* No. II. appeared March 10th.

Pneumatic Tools.

The Consolidated Pneumatic Tool Company, Limited, of 170, Piccadilly, London, W. 1, had a large stand on which there was exhibited a large number of pneumatic and electric tools, many of which were shown in operation in connection with an electrically driven air compressor having a cylinder 6in. by 6in. and capable of delivering about 69 cubic feet of free air per minute against a pressure of from 80 lb. to 125 lb. per square inch. There were examples of all the familiar tools made by this company, and in the centre of the stand there was a big baulk of timber on which the capacities of the wood boring tools were demonstrated. Besides these there was a small oil-heated rivet forge, which takes its air supply direct from the compressed air mains at the normal pressure, and an electric welding machine. The welding machine is of the resistance type and can be adapted for either spot welding or continuous seam work.

Gas Engines.

Crossley Brothers, Limited, of Openshaw, Manchester, had a large stand on which several gas engines were at work. They comprised one of 31 to 34 brake horse-power, another of from 22½ to 25 horse-power, and two smaller sets of 6¾ and 7½ horse-power respectively, together with a gas-producing plant of 21 horse-power. There was also on this stand a hand-

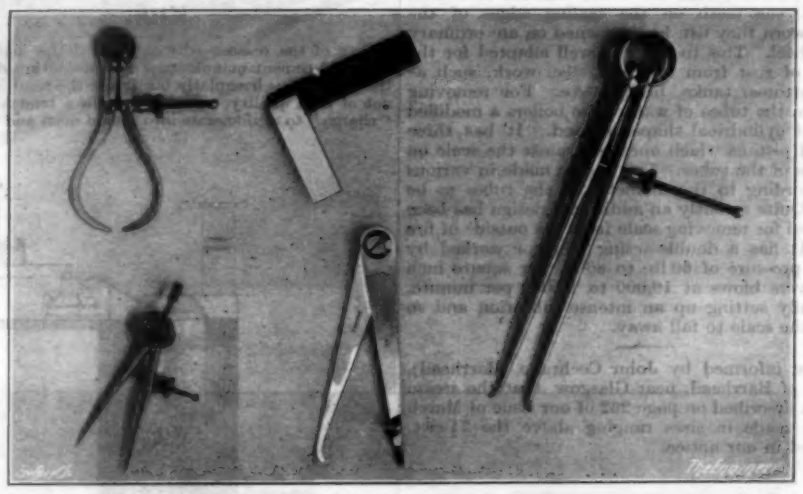


FIG. 20—SMALL ENGINEERS' TOOLS—C. A. VANDERVELL AND CO.

some enlargement of a photograph of the large four-cylinder single crank gas engine at the Wolverhampton works of Alfred Hickman, which has already been described in THE ENGINEER. This engine, it will be remembered, was constructed by the Premier Gas Engine Company, of Sandiacre, which is associated with the Crossley Company. The construction and high quality of the Crossley gas engines is so familiar to our readers that it is unnecessary to enlarge upon them here.

Gauges and Measuring Instruments.

The Coventry Gauge and Tool Company, Limited, of Coventry, had a fine exhibit of gauges, both screwed and plain, an optical comparator, by means of which all the principal dimensions of screws can be checked to within one ten-thousandth of an inch by semi-skilled operators, and a variety of small tools, such as milling cutters, broaches, &c. There was also a new form of split screw gauge, which is of very robust form and will, we were told, stand repeated falls on a hard floor without damage. The gauge is capable of adjustment to compensate for wear, but the adjusting screws are completely covered by the casing, so that the gauge cannot be tampered with by unauthorised people.

On the same stand there were some very nicely finished sheet metal stampings by Pressings, Limited, of Cow Lane Works, Coventry. The examples, which principally took the form of electric meter cases, were noteworthy on account of their smooth finish and absence of ragged edges, while all the corners were well defined and the dimensions adhered to with accuracy.

Small Tools.

A stand of special interest on such an occasion was that of C. A. Vandervell and Co., Limited, of Acton, London, W., where a number of small tools, such as callipers, squares, gauges, &c., were exhibited, some of which are shown in Fig. 20. These tools have been specially put upon the market with the object of providing a British-made article in competition with the American-made tools which are so frequently seen in engineering workshops, and for this purpose the makers have equipped a factory, put up in Brighton during the war for making magnetos. The tools are all of a finish which compares favourably with those imported from America, and such items as V blocks are guaranteed to possess a very high degree of accuracy. It is, we understand, the intention of the firm continually to extend the range of tools, already fairly considerable, which are made at its works.

Boilers and Superheaters.

On the stand of H. and T. Danks (Netherton), Limited, of Netherton, Dudley, there was a full-sized model of a boiler front-plate fitted up with standard fittings and erected in a glazed tile setting, while there were photographs of various other manufactures by this firm, such as tanks, chimneys, and general plate work.

Back to back with this stand was the exhibit of Dee Superheaters, Limited, of Bishton's Bridge, Netherton, which comprised a number of superheater elements for Lancashire and similar boilers. These superheaters were recently described in THE ENGINEER, at which time they were being manufactured by H. and T. Danks; but the business in superheaters has since been taken over by the present makers. In the annexe, at the extreme of the Fair, the Dee Company also had a large superheater made to suit a new form of water-tube boiler, which is shortly to be put upon the market by H. and T. Danks.

Fire-bricks and Refractories.

We were forcibly reminded of the discussion on the qualities of British fire-bricks which took place recently at the Institution of Mechanical Engineers, by the exhibits of Yorkshire Amalgamated Products, Limited, 27, Waterdale, Doncaster. On the stand there were examples of plain fire-bricks and "specials" for building retort settings and so forth. The company's representative informed us that in the case of the silica bricks supplied for lining Siemens furnaces the dimensions are guaranteed to be within 2 per cent. of the nominal sizes. Some special bricks are being made with very little lime in them and, being capable of withstanding temperatures up to 1750 deg. Cent., are suitable for electric furnaces. Among the other products exhibited on this stand there were samples of crushed quartzite for concrete making, which gives a very strong mixture, and limestone ground to pass a 200-mesh screen for road filling in connection with a bituminous binder.

High-pressure Valves.

In view of the modern tendency to increase steam pressures and temperatures, the valves exhibited on the stand of Hunt and Mitton, Limited, Oozells-street North, Birmingham, were of special interest. These valves are all fitted with seatings of "Nickloy," a special metal which the makers have evolved to withstand the effects of high-temperature steam. Tests which have been carried out at the Birmingham University show that "Nickloy" has a Brinell hardness of 245 at a temperature of 46 deg. Fah., while it is only reduced to 196 when the temperature is raised to 700 deg. Fah., and the tensile strength is from 15 to 17½ tons per square inch at 800 deg. Fah. Some samples of the alloy were shown on the stand in process of being tested for corrosion by mine water and brine, and it was noteworthy that they were withstanding the test well. Among the valves exhibited there was a high-pressure parallel slide valve with "Nickloy" faces, intended for a steam pressure of 350 lb. per square inch and a high degree of superheat.

Switchgear.

The chief exhibit on the stand of A. Reyrolle and Co., Limited, Hebburn-on-Tyne, was an electrically operated armoured switch panel for power-houses,

of the type which has already been described in The Engineer. In these switches the operating mechanism is quite distinct from the current-carrying parts, and it can be removed bodily from the panel, so that it can be attended to in complete safety. In some large power stations schemes the switchgear must be controlled from a special chamber, sometimes situated in a separate building altogether, and for such cases an electrical control is indispensable. In order to meet these requirements a solenoid mechanism is mounted upon any size of standard armoured switch, which then plugs into standard gear with either single, duplicate, or triplicate bus-bars. The outstanding feature of these switches is, of course, the total enclosure of all the live parts in a strong metal casing, which obviates the necessity for building special cubicles for the gear. They are made in various sizes for use on systems employing up to 66,000 volts. In addition to the switchgear there were some motor starters and oil-break switches for colliery work, various other types of switches and wall plugs specially designed to comply with the new Home Office rules as regards earthing.

Scaling Tools.

Mr. Frank Gilman, of Wilders Drive, Warwick-road, Birmingham, exhibited a number of tools for scaling boilers and similar purposes, some of them being of comparatively new design. Most of the tools are worked by compressed air, but some of the new types are operated electrically or by water pressure. One of the air-driven tools, which is intended for scaling Lancashire, marine, Cornish, locomotive, vertical and other boilers, and also for cleaning the drums of Babcock, Stirling and Woodeson boilers, delivers from 8000 to 10,000 blows per minute according to the pressure of air used, and requires about 16 cubic feet of air per minute at a pressure of 60 lb. to 80 lb. per square inch. The scaly plates are put into a state of intense vibration, with the result that the scale falls away. If the teeth on the scaling edges of the tool get worn they can be sharpened on an ordinary emery wheel. This tool is also well adapted for the removal of rust from iron and steel work, such as ships' bottoms, tanks, bridges, &c. For removing scale from the tubes of water-tube boilers a modified design, of cylindrical shape, is used. It has three staggered pistons which operate against the scale on the inside of the tubes. This tool is made in various sizes according to the diameter of the tubes to be scaled. Quite recently an additional design has been introduced for removing scale from the outside of fire tubes. It has a double-acting vibrator worked by air at a pressure of 60 lb. to 80 lb. per square inch and delivers blows at 10,000 to 12,000 per minute, incidentally setting up an intense vibration and so causing the scale to fall away.

We are informed by John Cochrane (Barrhead), Limited, of Barrhead, near Glasgow, that the steam hammers described on page 262 of our issue of March 10th are made in sizes ranging above the 7½ cwt. mentioned in our notice.

Large Grinding Machine for Chilled Iron Rolls.

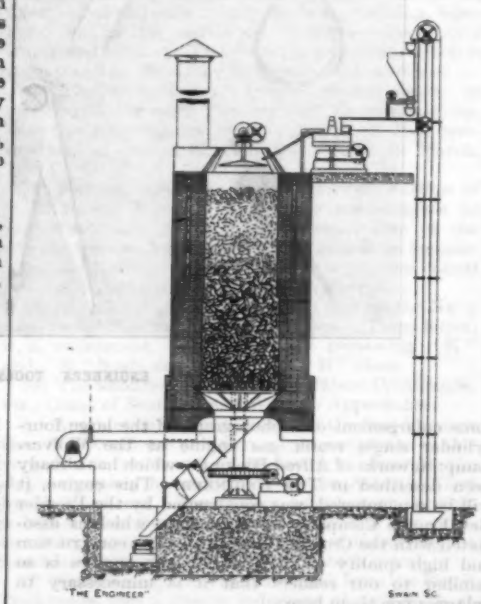
For the finishing of chilled iron rolls during manufacture and for trueing up rolls after periods of usage, as well as for trueing up the calendar bowls and heavy rolls used in sheet metal mills and rubber manufacturing machinery, grinding is gradually, if not rapidly, being accepted as being the most efficient and economical method. Looked at from the rolling mill manufacturer's point of view, grinding possesses many advantages. It is an economical practice to rough-turn the roll necks in the roll-turning lathe and to grind the chilled portion of the roll surface direct from the casting, as the chilled metal can be ground away more quickly than it can be turned away in the roll-turning lathe. Certain processes of manufacture entail rolls with cambered surfaces. Where such a requirement has to be met the grinding machine is equipped with a cambering motion consisting of a camber bar, which, by means of a variable reducing mechanism and a series of levers, will grind the cambered roll of the desired curvature. Further, it is possible to produce rolls within very fine limits of error at less cost than by turning, and, what is also of great importance, the effective life of the roll is increased owing to the fact that the grinding machine trues up a roll by grinding to the lowest worn portions of the faces, therefore economising the depth of chill. The latter point is probably the chief argument in favour of grinding. It is only possible to chill a roll to a small depth, and it is the life of this chilled skin which determines how long the roll will render useful service. A single-point tool operating on a roll must necessarily take a comparatively heavy cut to get below the surface, and it is due to that fact that the grinding wheel, which only removes the minimum of metal to produce a true cylinder, is being more widely employed than used formerly to be the case.

The heavy roll grinding machine illustrated on page 307 has a capacity for work up to 36in. diameter by 18ft. between the centres. It has been constructed by the Churchill Machine Tool Company, Limited, of Broadheath, to the order of a North Country firm which is engaged in the manufacture of sheet metal. As will be observed from the accompanying engravings, the machine has a moving work table, the method of operation being to support the roll on its two necks on the special supports provided, fixing it endways between the two centres and rotating it through the Clements driver by means of a 20 horse-power direct-current variable-speed motor and the two-speed gear arranged on the work head. The operation of the grinding wheel, the table reciprocating motion, and other auxiliaries is effected by means of a direct-coupled 35–40 horse-power electric motor placed at the rear of the machine. The heavy flat table operating on a widely spaced vee and flat slide with large area and length is designed to carry a roll of 20 tons weight without sign of distortion, the alignment of the work head, roll supports, and tailstock being secured from the flat and angular surfaces of a projecting slip cast integral with the table. The wheel head, shown very clearly in the end view, is of massive construction, and carries a grinding wheel 26in. diameter, with a face of 5in., which is capable of removing metal from a chilled iron roll at the rate of 2 cubic inches per minute when roughing, and provides for a reliable operating time estimate of 1½ cubic inches per minute, including the finishing operation. One of the details of the machine of special significance is the means of supporting the roll while grinding is proceeding. The stays which support the weight are so designed that no matter what shape the journals may be when the work comes to the machine, they can be quickly reduced to true cylindrical form and provide, when finally trued up, an accurate setting on which the grinding working surface of the roll can then proceed.

In considering the grinding of a heavy job, such as a sheet metal mill roll, absolute rigidity of the roll is essential. To secure maximum service from the grinding wheel, evenly disposed weight in the wheel head and its supports is a *sine qua non*, for while it is possible to grind a roll with a poorly designed wheel support and to remove the surplus metal from the work surface within a reasonable time, the operation will not be performed efficiently on account of the excessive wear which will take place on the grinding wheel. In the Churchill wheel-heads it is claimed that the weight is disposed in places where its influence is most effective in damping out self-generated vibrations, and even wear of the abrasive wheel results.

A New Type of Portland Cement Kiln.

One of the reasons why the use of the shaft kiln for Portland cement manufacture was discontinued was that the clinker was irregularly burnt and the resulting cement not of high quality. There was also a tendency for the "charge" to agglomerate into a solid mass and to become



SELF-DISCHARGING SHAFT CEMENT KILN

fused to the side of the kiln. These defects more than counterbalanced the advantage possessed by this type of kiln in the direction of fuel consumption.

From information which has reached us, it would appear that by means of certain modifications which have recently been introduced these troubles have been entirely overcome, and that, furthermore, the removal of the clinker from the kiln is effected automatically, and not, as was formerly the case, by hand. The idea of the improvements originally occurred some twelve years or so ago to a cement manufacturer in Southern Hungary, and he had it put into mechanical shape by the firm of Curt von Grueber, of Berlin, which has since acquired the patents and has practically re-designed the plant.

Briefly explained, the new type of kiln consists of a circular vertical shaft, lined, of course, with refractory material, and slightly smaller in diameter in its upper than in its lower half. At its lower extremity is arranged a massive circular revolving horizontal grate, which is furnished on its upper face with projections or teeth for breaking up the clinker, and has also a number of holes perforated in it for the passage of the pieces of broken clinker. The speed of revolution of the grate is very slow, and is adjusted so that the burnt clinker may be discharged at the exact rate at which complete burning can be effected. The result is that the material in the shaft is kept moving downwards at an even speed, and that the burning zone is maintained practically at one level. It is asserted that this constant movement entirely prevents fusing of the charge to the sides of the kiln. Immediately below the grate air under pressure is delivered from a variable-speed fan, so that the burning of the clinker is effected under forced draught. The air on its way to the burning zone passes through, and partially cools, the bed of burnt clinker, becoming itself heated in the process. The hot gases given off from the firing zone serve to dry the raw materials before they reach the latter. It is claimed that a perfect regeneration system is thereby obtained, that the loss by radiation is slight, and that the only heat not directly used is that necessary to maintain the moist vapours in the chimney above the condensation point.

An undoubted disadvantage of the system is that the mixed raw materials have to be briquetted before being charged into the kiln, but it is claimed that it is more than counterbalanced by the fact that the fuel has not to be pulverised, but only to be reduced to the size of peas. It is stated, too, that the kilns can be shut down for several days and then readily started again, so that manufacturers can, without detrimental results, cease production over week-ends and during holidays or slack times. The raw materials have, of course, to be mixed dry. Some 10 per cent. of water is added just before briquetting takes place.

It may be added that the clinker, as it is delivered by the revolving hearth, passes into a specially designed hopper fitted with an air lock, which, while allowing the clinker to be discharged, prevents loss of air pressure under the grate. The device also prevents the emission of dust to the atmosphere. The clinker produced is described as being in comparatively small pieces, such as would pass through a 3in. mesh riddle, well burnt, and of a highly honeycombed structure, which enables considerable economy in the subsequent grinding operation, as compared with rotary kiln clinker, to be effected. The quality of the cement made from this rotary grate kiln is, it is stated, equal in every respect to that from rotary kilns when using the same raw materials.

It sounds like a retrograde step to revert to shaft kilns, but if the claims put forward can be substantiated, the system is certainly economical in fuel. The statements are made: (*a*) That it has been definitely proved in practice that, owing to the efficient utilisation of the heat a saving of over 30 per cent. of the fuel used in rotary kilns is effected; (*b*) that the weight of average quality fuel used is 16 per cent. of the finished product; and (*c*) that with higher-grade fuel as little as 50 lb. per barrel is all that is necessary. As regards the power required, the grate itself takes, we understand, from 2 to 3 horse-power, while the total power per kiln, including that for working the briquetting press, feeding device, and fan does not exceed from 18 to 20 horse-power. For operating a three-kiln plant producing 300,000 barrels per year only two men are, so it is said, required per shift.

The representative of the system in this country is Mr. T. F. Miller, of 8–9, Broad Street-avenue, London, E.C. 2.

CANADA AS A FIELD FOR BRITISH INDUSTRIES.

The Commercial Intelligence Service of the Canadian Department of Trade and Commerce has recently published an exceedingly well got up pamphlet entitled "Canada as a Field for British Industries." "Pamphlet" is the description applied to the publication in its introduction, but actually it is a volume running to some 130 pages. In it it is sought to present certain facts and figures dealing with the Canadian industrial situation, in such form as to attract the attention of British manufacturers to the field which the Dominion offers to their energies and enterprise.

It is pointed out that the situation as it appears to Canadians is that the Dominion possesses immense possibilities for industrial development. It is well served by a network of railways, and for export trade excellent steamship facilities provide connections with all the principal countries of the world. It possesses, in addition, a Commercial Intelligence Service with some twenty-two Trade Commissioner Offices established abroad at strategic trade centres.

For some years past, and in growing numbers, United States manufacturers have been realising that Canada presents favourable opportunities for the establishment of branch industries, and have been setting up factories in the Dominion. Canadians welcome this influx of American capital, enterprise and energy. Yet—to quote from the book itself—"Contemplation of this addition to their national wealth contains within it a certain regret . . . perhaps only now commencing to be felt; it is that manufacturers of the United Kingdom are taking so little part in the industrial development of the country. This regret does not spring from selfishness, for although it may seem over-confident to say so, there is little fear of a lack of new industries in the future. But Canada is British through and through, and the hope of Canadians is that the Dominion may develop in the future as it has in the past, along British lines."

Canadians, it is explained, do not presume to advise British manufacturers as to the best course to pursue; yet they venture to believe that many of them can find in the Dominion a profitable outlet for their enterprise, and to show them just how matters stand at the moment the present volume has been produced. It is divided into nine chapters and two appendices. The titles of the former are:—"The Economic Areas of Canada"; "Natural Resources in Relation to Industry"; "Canadian Trade Past and Present"; "Labour in Canada"; "Water Powers and their Industrial Importance"; "Canadian Tariffs and Trade Arrangements"; "Transportation Facilities"; "Company Incorporation and Taxation"; and "A Note on the Canadian Banking System." The book contains a vast amount of extraordinarily interesting information, and is profusely illustrated with half-tone engravings, maps and diagrams.

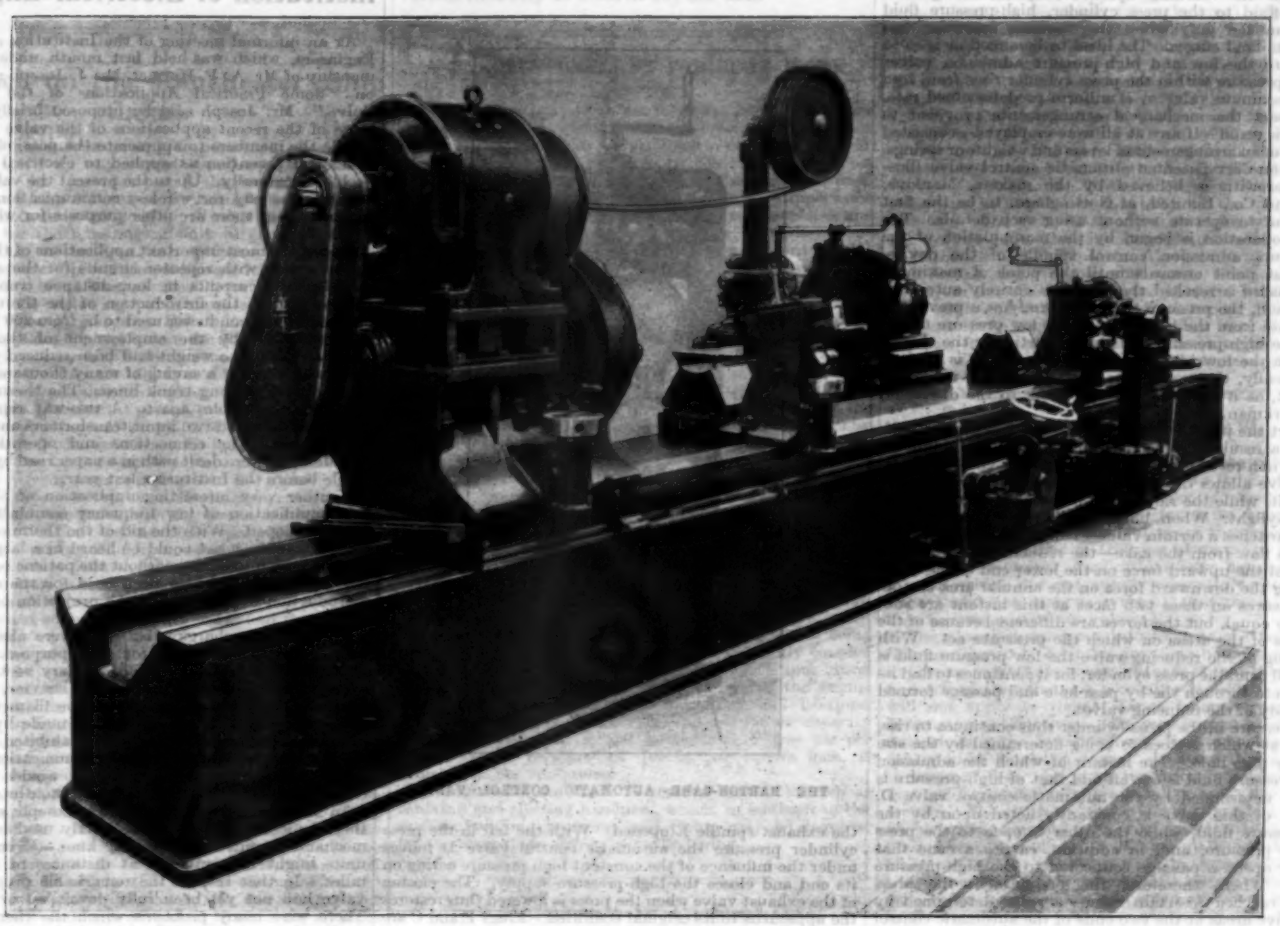
Manufacturers interested in the possibilities for the establishment of branch factories in Canada may obtain copies of the pamphlet gratis on application to the Canadian Trade Commissioner in London, whose office is at 73, Basinghall-street, E.C. 2.

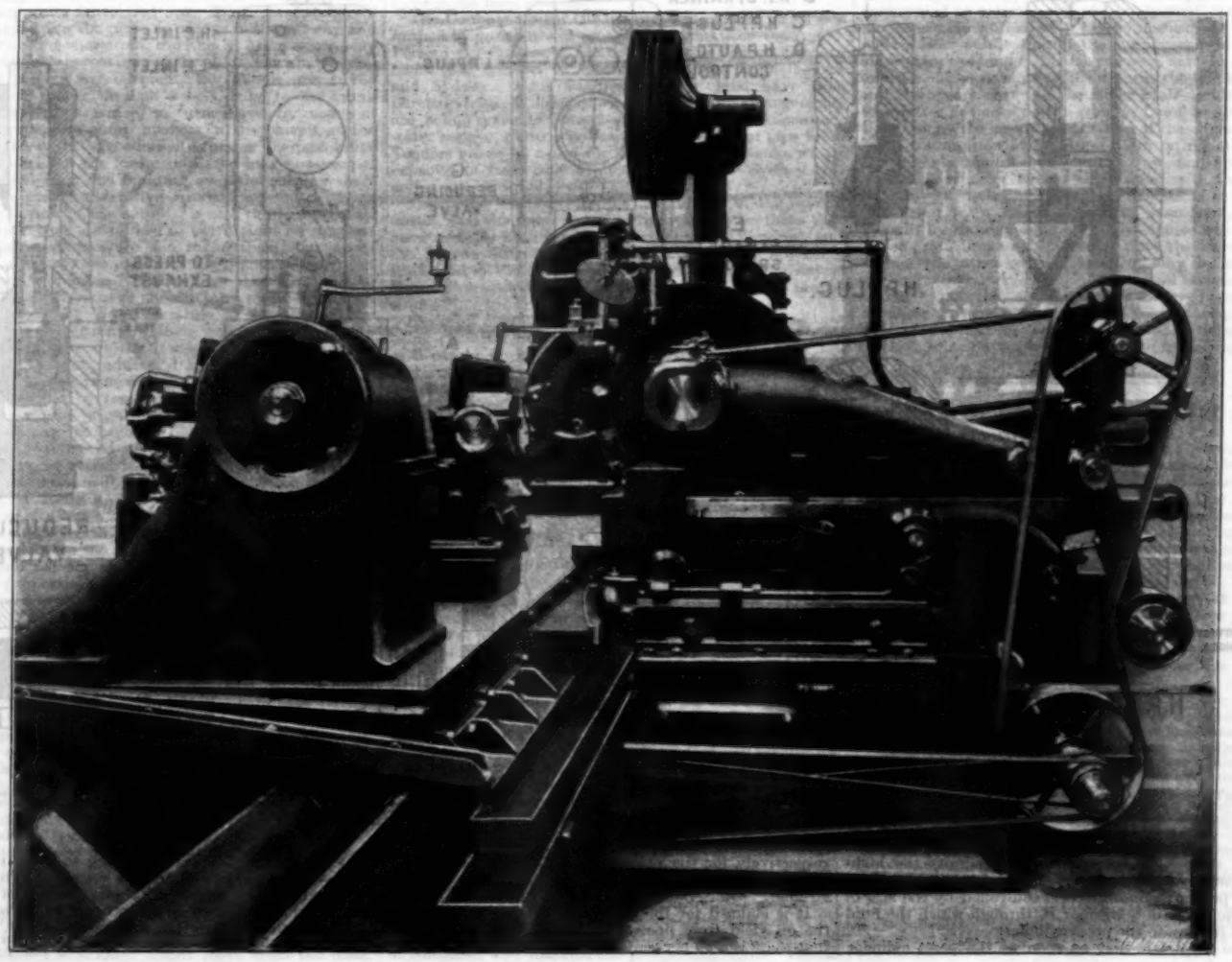
Owing to the higher cost of wages and coal, the locomotive running expenses per train mile on the Great Northern last year were 17.28d., as against 4.55d. in 1913.

GRINDING MACHINE FOR CHILLED IRON ROLLS

THE CHURCHILL MACHINE TOOL COMPANY, LIMITED, BROADHEATH, ENGINEERS

(For description see opposite page)





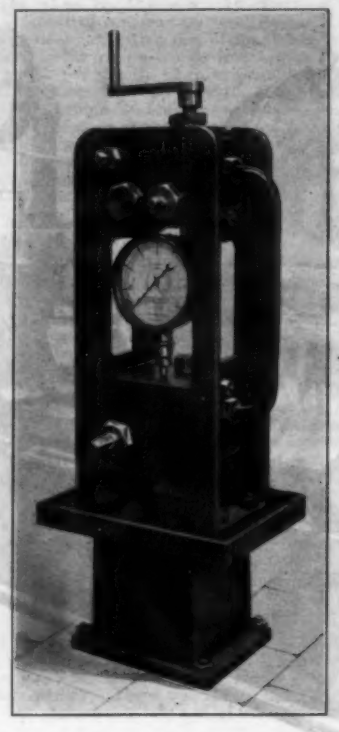
Automatic Control Valve for Hydraulic Presses.

In the operation of certain types of hydraulic press, for example, those used in the seed crushing industry, it is desirable on the score of economy to execute the earlier portion of the working operation by admitting low-pressure fluid to the press cylinder, high-pressure fluid being admitted only when the working operation has reached its final stages. The ideal to be aimed at is so to manipulate the low and high-pressure admission valves that the pressure within the press cylinder rises from zero to the maximum value at a uniform predetermined rate. In the past the mechanical arrangements provided to secure this result—if any at all were employed—consisted generally of an arrangement of levers and weights or springs. The Barton-Carr patented automatic control valve illustrated herewith is believed by the makers, Manlove, Alliott and Co., Limited, of Nottingham, to be the first of its kind to operate without using such details. The pressing operation is begun by the manipulation of the low-pressure admission control spindle of the device. From that point onwards until the point of maximum high pressure is reached the device is entirely automatic in its action, the pressure rising uniformly at a previously settled rate from the beginning of the low-pressure to the end of the high-pressure period. In particular the change over from the low to the high-pressure supply is effected automatically, the exact instant at which it is made not being left, as it is with hand operation, to the discretion of the workman.

To start the press the pressure spindle A is given a half-turn, as a result of which low-pressure fluid is admitted past the non-return valve to the reducing valve G. The latter valve allows the low-pressure fluid to flow full bore through it, while the ram of the press is rising and taking up the daylight. When, however, the pressure in the press cylinder reaches a certain value—namely, that at which oil begins to flow from the cake—the reducing valve rises as a result of the upward force on the lower end of the valve exceeding the downward force on the annular area on top. The pressures on these two faces at this instant are substantially equal, but the forces are different because of the difference of the areas on which the pressures act. With the closing of the reducing valve the low-pressure fluid is not cut off from the press cylinder, for it continues to find its way thereto through the by-pass hole and passage formed in the body of the reducing valve.

The pressure in the press cylinder thus continues to rise, the rate at which it does so being determined by the size of the by-pass hole. The instant at which the admission of low-pressure fluid is cut off and that of high-pressure is begun is determined by the automatic control valve D. One end of this valve is constantly acted upon by the high-pressure fluid, while the other is open to the press cylinder pressure, and, in addition, carries a cone that closes or opens a passage connected to the high-pressure supply. When, therefore, the pressure in the press cylinder reaches a certain value—a value determined by the relative areas at the two ends of the automatic control valve—the cylinder pressure overcomes the constant high pressure ribs above the maximum low-pressure valve the non-return valve on the spindle A closes and cuts off the supply of low-pressure fluid. It should also be noted that the automatic control valve is surrounded by two packing leathers with a chamber between, and that this chamber is vented to the outside, so that the fact that the leathers require renewing will be made manifest by the escape of fluid through the vent hole.

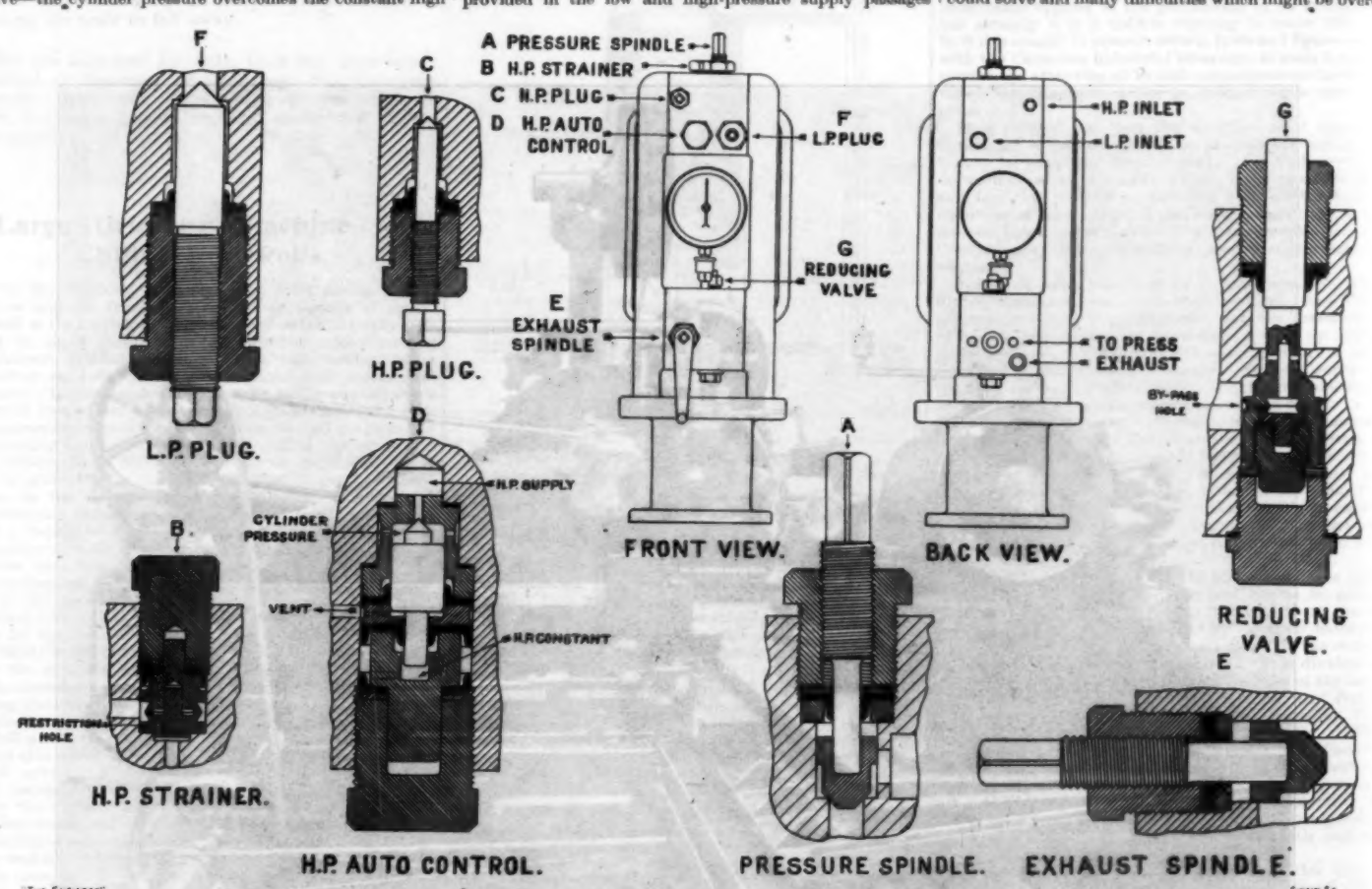
To lower the press the spindle A is screwed down and



THE BARTON-CARR AUTOMATIC CONTROL VALVE

the exhaust spindle E opened. With the fall in the press cylinder pressure the automatic control valve D moves under the influence of the constant high pressure acting on its end and closes the high-pressure supply. The closing of the exhaust valve when the press is lowered thus restores the apparatus to its original condition. Plugs F and C are provided in the low and high-pressure supply passages respectively for the purpose of shutting off the supplies when it is desired to renew the leathers or clean the strainer.

It is claimed for the device that its use has increased the oil yield from linseed by one-half to one per cent.; that there is a 50 per cent. reduction in the "foots"—the fluid that can be squeezed out of the cake—and that it economises the press bagging to the extent of 20 per cent. It is to be added that, if necessary, the device could be adapted for use with three instead of two pressures.



DETAILS OF THE BARTON-CARR AUTOMATIC CONTROL VALVE

It is to be noted that as soon as the press cylinder pressure. The valve then opens and admits the high-pressure supply to the press cylinder. The rate at which the high pressure is admitted is controlled by the size of a restriction hole in a strainer B, through which the fluid passes on its way to the press cylinder.

Institution of Electrical Engineers.

At an informal meeting of the Institution of Electrical Engineers, which was held last month under the chairmanship of Mr. A. F. Harmer, Mr. J. Joseph read a paper on "Some Practical Applications of the Thermionic Valve." Mr. Joseph said he proposed briefly to outline some of the recent applications of the valve or triode to enable the members to appreciate the possibilities of that wonderful invention as applied to electrical engineering problems generally. Up to the present the valve had been employed chiefly for wireless communication over great distances, but there are other purposes for which it could be used.

One of the most important applications of the valve was in connection with repeater circuits for the amplification of telephone currents in long-distance trunk telephone cables. Before the introduction of the thermionic valve the weight of a conductor used to be from 200 lb. to 600 lb. per mile, but by the employment of the thermionic repeater relay, the weight had been reduced to 20 lb. per mile, which meant a saving of many thousands of pounds in a network of long trunk lines. The thermionic relays were placed 30 miles apart. A two-way repeater for up and down lines had two input transformers and one output transformer. The connections and operation of those transformers were dealt with in a paper read by Sir William Noble before the Institution last year.

Another very interesting application of the valve for the amplification of low frequency sounds had recently been developed. With the aid of the thermionic amplifier the beat of the heart could be heard in a large room and, what is very important, without the patient being aware of it. The valve had also been used for the simultaneous reproduction of speech with the projection of a film on a screen.

Rectifiers for charging batteries were also considered. The design of the valve for that purpose, Mr. Joseph explained, was similar to the ordinary rectifying valve, except that the filament was much heavier, and the disposition of the anode relative to the filament somewhat different. The "Tungar" rectifier made by the British Thomson-Houston Company was exhibited. By means of the valve, Transatlantic communication by radio-telephony on a commercial scale would certainly be established within the next eighteen months or two years.

In his concluding remarks Mr. Joseph said that the thermionic valve might be indirectly used for controlling mechanical contrivances of any kind. Even large power units might be controlled at distances of thousands of miles. In that respect the remarkable properties of the valve had not yet been fully developed or appreciated. There were many problems which the thermionic valve could solve and many difficulties which might be overcome by its agency. It was gratifying to know that the best valves were produced in this country. That had been proved by the recent Admiralty report on the subject after exhaustive tests on a number of valves obtained from every country where they are manufactured.

The subsequent discussion was led by Mr. P. Dunsheath.

who spoke on the applications of valves to break-down tests in cables. He was followed by Mr. S. R. Mullard, Professor P. M. Baker, Professor C. L. Fortescue, Mr. Leslie Miller, Mr. E. Kilburn-Scott, Major Tucker, P. Coursey, C. A. Newell, —. Robinson, A. Rosen, —. Bell, and Mr. A. F. Harmer. Mr. Joseph then replied to the points raised and expressed his thanks for the loan of apparatus to Messrs. Mullard, Messrs. Marconi, Osram, and Mr. S. G. Brown.

Oil Dock on the Manchester Ship Canal.

In order to encourage the importation of oils and petroleum spirit by way of the Manchester Ship Canal, the company has just completed the construction of a new dock at Stanlow Point in the Eastham section of the Canal. This dock is being equipped with the most recent appliances for the handling of bulk cargoes. Owing to the nature of the cargoes, it is situated in an isolated position, and every precaution is being adopted to prevent the possibility of ignition of the oils or vapours arising from them. The following particulars, are taken from a paper on "The Engineering Developments of the Manchester Ship Canal" read before the Manchester Association of Engineers by Mr. William Fox, M.I. Mech. E.

The main pipe lines are laid from a jetty erected at the centre of the dock side through a subway constructed under the Canal, and after passing out of the south shaft of the subway, these are provided with reflux and stop valves and lead to the various oil companies' storage tanks. The subway has been designed for six pipe lines, four of which have already been installed and the remaining two reserved for future extensions. This arrangement allows for the oil from the main line of pipes to be diverted as required to any of the pipe lines connected with the private oil companies' tanks. The pipes, which are 11in. diameter as far as the outlet from the subway, and 10in. from that point to the storage tanks, are constructed of mild steel, lap welded, and connected together by screwed couplings, the latter when screwed up being welded to the pipes to prevent leakage.

The delivery branch of the ship's pump is connected to the fixed oil mains ashore by means of flexible hose, which is carried over the bulwarks of the vessel by specially constructed cradles suspended either from a hand crane on the jetty or from the davits of the vessel itself. After the pumping operations from a vessel have ceased, oil remains in that portion of the discharge pipes between the jetty and the stop valves, and as this has to be delivered to the oil company to whom it belongs, electrically driven deep-well pumps have been provided at the head of the south shaft of the subway, for the purpose of clearing the oil from the pipe mains. The working barrels of these pumps are situated at the bottom of the shaft, the suction pipes being connected to the various oil mains in the subway. The delivery pipes lead from the rising mains at the top of the shaft and are joined to the main oil pipes above ground at points beyond the stop and reflux valves to which reference has already been made.

This type of pump, supplied by Thomas Matthews, Limited, of Pendleton, was adopted after some deliberation as being the safest for the conditions under which the pumping must be carried out. With the liability of petrol leakage from the pipes or pumps in the subway and the danger arising therefrom, the idea of using electrically driven pumps at the bottom of the shaft was abandoned. Under the present arrangement, the pumps are driven by an electric motor through a belt drive to the crank shafts of the pumps, which, in turn, drive, by means of pitch pine rods, the pump buckets in the barrels at the bottom of the shaft. To eliminate further the possibility of fire or explosion, the motor is placed in a house separately situated from the building over the subway shaft in which the pumps themselves are erected.

The ventilation of the subway is also most important. The pipes carrying the oil are as spirit-tight as the best material and workmanship can make them, but every precaution must be taken and not the slightest element of risk allowed to remain. Presuming, therefore, that a certain amount of leakage should take place even in a vaporous form, the question arose as to whether the petrol fumes, on account of their greater density, were likely to accumulate at the lowest level in the culvert, while the current of induced draught would pass at a higher level without removing the vapour. The quantity of this vapour to be considered is, of course, indeterminate, but a very wide margin of safety was allowed when determining the capacity of the fan to be installed. Experiment has proved that if the vapour from five volumes of liquid petrol is mixed with 100,000 volumes of air, the resultant will not burn. As the fan installed at Stanlow by Keith and Blackman Company, Limited, is capable of dealing with 780,000 cubic feet of air and vapour per hour, it will be seen that the air removed by the fan can take up the vapour from more than 38 cubic feet of liquid petrol per hour without exceeding a non-flammable proportion.

With regard to the possibility of the air current induced by the fan passing over the heavier vapours, it has been concluded that as in the first place a constant breeze would be created in the subway, and, secondly, as the obstruction offered by the oil pipes themselves, the supporting brackets, and the flanges of the cast iron lining of the culvert would act as baffles and cause the flow of air to be of sufficient turbulence as to ensure a diffusion of any vapour present throughout the surrounding air, settlement of the heavier vapour would thus be prevented.

As further precautions against accident, the motor provided for driving the fan is installed in a separate and enclosed house, the driving shaft passes through a grease-packed gland box fitted in the wall, and the air drawn from the subway is exhausted through a light steel chimney into the atmosphere at a height of 30ft. above the roof of the fan house.

The steam generating plant which supplies steam to the ships' pumps for discharging vessels consists of two Babcock and Wilcox boilers of the water-tube type, fitted with superheaters, oil-firing apparatus and all auxiliaries. This installation is situated about 300ft. from the dock. The boilers are each capable of evaporating 12,500 lb. of water per hour at 120 lb. per square inch, the steam being conveyed to the dock by a range of 6in. diameter solid-drawn steel pipes, terminating at a jetty by a special connection, which by means of flexible metallic hose may be coupled to the engines or cylinders of the direct-acting pumps on the ships. Taper reducing pipes and Y pipes are also provided, so that either one or more flexibles of various sizes may be fitted at any one time.

A PNEUMATIC PLANT FOR ROAD WORK.

During the past week considerable interest has been displayed in the pneumatic road-breaking installation which is being used by John Mowlem and Co., Limited, in connection with their Holborn contract for the Post Office. The use of pneumatic tools for mining and engineering work is familiar to most of us, but the application of pneumatic hammers for breaking up road surfaces and pneumatic picks for cutting trenches is perhaps less familiar, and we therefore give a brief account of this installation, which has been supplied by Lacy-Hulbert and Co. (1921), Limited, of Beddington, Croydon. The plant consists essentially of a portable air compressing set, complete with the necessary air storage tank and air hose connections for the various tools.

The engine, which was made by Dormans, of Stafford, and the Lacy-Hulbert air compressor are mounted on a substantial steel frame, which is supported on four rubber-tired wheels which greatly facilitate the transport of the machine from place to place, and also help to reduce noise and vibration when the engine is running. The latter, which works on paraffin, is of compact design, having four cylinders. It is provided with a special governor for close speed regulation, and has magneto ignition. Cooling is effected by means of a radiator and fan in the usual way. The air compressor is totally enclosed, and has two cylinders. Like the engine, it is lubricated by splash lubrication. There is a special unloading valve of simple design, which automatically throws the load on or off when the air pressure in the receiver falls below or reaches the required point at which the device is set. The compressor is water cooled, a special tank being provided for the purpose. The engine is directly coupled to the compressor through steel and cast iron spur gears, the solid cut pinion shaft being coupled to the engine crank shaft and carried in self-aligning ball bearings. An air storage receiver, of a size suitable for the capacity of the plant which is 130 cubic feet of free air per minute at a pressure of 100 lb. per square inch, is attached to the compressor.

Arrangements are made to connect any tools, such as caulking and riveting hammers, which, in addition to the surface breaking hammers and picks, may be required for the operations of pipe or cable laying.

OIL PROSPECTING IN AUSTRALASIA.

The Commonwealth Government has decided to extend the period of oil prospecting licences in the Northern Territory from one to five years. One hundred licences have so far been granted.

The Commonwealth Oil Refineries, Limited, which was formed in pursuance of an agreement between the Anglo-Persian Oil Company, Limited, and the Federal Government, has decided to establish refineries in Melbourne and Sydney. Four hundred acres of land have been purchased near Williamstown (Victoria), and arrangements are being made for wharf and railway accommodation, water service, electric power, and the laying of pipe lines. Tenders are to be called for the supply of oil tanks with a capacity of from 2000 to 10,000 tons. The Sydney refineries will be established at a later date.

Boring for oil is proceeding assiduously in the several States, and the most promising indications are those that have recently been reported from Kilmore (Victoria), and the Barcoo district (Queensland). Operations are being continued in Victoria despite the fact that the Ministry of Mines characterised the ventures as "hopeless propositions."

Shale oil operations at Newnes, New South Wales, are being curtailed, as the oil cannot be supplied as cheaply as it can be imported into the country. Those interested declare that there are many millions of gallons of oil in the deposits at Wolgan, but the problem is to discover an economical method of extracting it.

According to advices from Wellington (New Zealand), a fresh attempt is under way to exploit the Taranaki oil wells. A start is being made with the Blenheim bore, where deposits at the 2000ft. level will be tested.

THE MINERAL RESOURCES OF OUTER MONGOLIA.

The following notes on the mineral resources of Outer Mongolia are taken from the Chinese *Industrial Magazine*.

The mineral wealth of Outer Mongolia has been the subject of much speculation from time to time, but development schemes are frustrated by the antipathy of the Mongolian nobles, who consider that such exploitation is not consonant with their religion. Superstition still seals many valuable deposits, which are known under the generic title of "The Hidden Treasure. There are many gold mines in the region, but few have been worked. In addition to silver, copper, and iron, Outer Mongolia has vast stretches of soda crystals and salt. Gold is present in the districts of Urga, Ulissutai, and the Altai mountain regions, and native methods are used in its exploitation. Russians are operating nine mines with a total annual output valued at 4,000,000 dols. Northwards from Urga to Kiahkta gold is found abundantly in almost every district. In this area there are fifteen operated and six unworked mines, which are variously owned by Russians, Mongols, and Chinese. The operated alluvial mines have a daily output of 1351 taels, and formerly belonged to the Mongolian authorities, though subject to the management of Russians, who obtained the prospecting rights. Recent events in Russia, however, have diverted much Russian enterprise, and Chinese exploiters have entered the field. Several Chinese mineowners have endeavoured to resume operations on the unworked deposits, but their efforts have been retarded by the hostility of the natives

Other mines with deposits of minerals other than gold are the Chenping silver mine, the Szetaokow copper mine, the Yimatotaonaika copper, gold, silver, iron and tin mines, the Daerhan copper, gold, silver, iron, and tin mines, and the Sipaishan (Chengkokung) sulphur mine. All these mines are not yet worked. There are several coal mines also, the three principal being the Lanaiho coal pit, which was first worked in 1915 by the Mongolian Government under Russian supervision. It is situated about 33 miles south-eastward from Urga and only one-third of a mile from the railway line to Kalgan and Manchuli. Its output is of a poor quality. From 1916 to 1918, some 40,000 tons of coal were produced from this pit. At present, the administration is under the Director-General of the North-Western Frontier Defence Force, but the mine can be worked by anybody at the fixed rate of taxation. The high charge of transportation enhances the price of the coal. The annual consumption of coal in Urga is estimated at 100,000 tons. The second mine is on the Chinsinshan and Pingshan coal seam. The quality of the coal from this seam is very good, but great difficulty has been experienced in the past from floods. The Kaituin coal seam, the third, lies about 3 miles from Kiahkta. A Russian discovered the coal seam quite recently, and reports show that it would be worth while working.

JAPANESE PATENT LAW.

Changes have recently been made in the patent law of Japan which will probably improve the value of Japanese patents and facilitate the obtaining of effective grants. Although Japan has been a favourite country with patentees, yet for a number of years the procedure and results have appeared in the eyes of many to have been very unsatisfactory. Applications have been rejected on grounds which did not appear adequate or the patents allowed did not seem to cover all that the inventor felt that he was entitled to protect.

The new laws were put into force at the beginning of this year, but it is desirable for those having applications at present on file to be aware of the fact that it is generally understood that the new procedure under the recent law will not apply to them. Japan being a party to the International Convention, one year is permitted from the date of filing the British specification to enable an application to be lodged in Japan. It seems that a patent is to be granted for any given invention to whoever applies first independently of any alleged priority, say of manufacture. The British inventor should therefore definitely file his application under the provisions of the International Convention, claiming his British date which will be effective, and not risk relying on the Japanese date.

Apparently, a single patent under certain circumstances may cover both process and apparatus, but substances made by chemical processes are not patentable. The examiner will make a search as heretofore, but provisions are made for dealing with the Examiner's objections, and it is thought that the new arrangements will result in less delay than has been heretofore experienced in the prosecution of Japanese applications. The Examiner will not be empowered to reject a case definitely until the applicant has been able to deal with his criticisms. An opposition period after publication of the specification is now to be allowed on the lines of British practice, namely, within two months of the date of publication in the official Gazette, and it appears that the Examiner shall decide finally on the matter not only on the grounds found in his investigation, but by the result of his study of the opposition.

Re-examination of the application on rejection by the Examiner is modified in the new law, and apparently a kind of hearing or trial is substituted with the rejecting Examiner a defending party. The case is at this stage considered by a group of several examiners, and it is thought by those in Japan that this course will give much better protection to the inventor than the former system. Among the other provisions there may be noted that working requirements are still made, and there are sections dealing with the grant of compulsory licences. The Japanese patent term is fifteen years dating from the date of publication, and all patented articles must be marked, or no damages can be claimed for infringement.

ELECTRIC VEHICLES IN THE UNITED STATES.

The demand in the United States for electrically driven passenger cars shows little improvement, but manufacturers of electric trucks state that the demand for their products is steadily if slowly increasing. One New York firm reports that it booked more orders between January 1st and February 15th this year than during the first five months of 1921, and other manufacturers tell more or less the same tale. From some recently published statistics concerning the 4362 electric trucks in use in New York City on January 1st, 1921, we learn that at that date there were 5 of such vehicles over twenty-three years old; 7 over twenty; 25 over eighteen; 33 over seventeen; 106 over fifteen; 221 over twelve; 980 over ten; 1580 over eight; 2448 over six; and 2899 over five years old.

New Boilers for Greenwich Power Station.—We are informed that the London County Council has placed an order with Clayton and Shuttleworth, Limited, Lincoln, for three Clayton water-tube boilers, superheaters, mechanical stokers, economisers, and forced and induced draught plant. These boilers are to be installed in the Greenwich Generating Station to replace some of the older boilers, and at the same time to give double the capacity in the same space occupied by the displaced boilers. Each unit will have a capacity of normally 48,000 lb. of steam per hour, and 60,000 lb. of steam per hour as a maximum. The working pressure is to be 200 lb. per square inch superheated to a total temperature of 550 deg. Fah., the guaranteed overall thermal efficiency being 84 per cent. The boilers will be of the curved tube drum type, embodying the Clayton double circulation principle, which, the makers claim, enables the boilers to be operated at very high duty with safety and durability.

Fatigue of Metals.

An extensive investigation of the fatigue of metals, which was carried out by Messrs. H. F. Moore and J. B. Kommers, of the University of Illinois, and is published in the *Bulletin* of the University for October 24th, 1921, concludes as follows :—

The general conclusions to be drawn from the results obtained in the investigation may be summarised as under :—

(1) For the metals tested under reversed stress there was observed a well-defined critical stress at which the relation between unit stress and the number of reversals necessary to cause failure changed markedly. Below this critical stress the metals withstood 100,000,000 reversals of stress, and, so far as can be predicted from test results, would have withstood an indefinite number of such reversals. The name "endurance limit" has been given to this critical stress.

(2) In the reconnaissance tests made in the field of ferrous metals no simple relation was found between the endurance limit and the "elastic limit," however determined. The ultimate tensile strength seemed to be a better index of the endurance limit under reversed stress than was the elastic limit. The Brinell hardness test seemed to furnish a still better index of the endurance limit. The reason why the Brinell test, and, to a less degree, the ultimate tensile strength, seem to be better indices of the endurance limit than the elastic limit is not clear, and this result should be regarded as tentative. Elastic limits determined from compression tests and torsion tests gave no better index than did those from tension tests.

(3) The single-blow impact tests (Charpy tests) and the repeated-impact tests did not furnish a reliable index for the endurance limit under reversed stress of the ferrous metals tested.

(4) Accelerated or short-time tests of metals under repeated stress, using high stresses and consequent small numbers of repetitions to cause failure, are not reliable as indices of the ability of metal to withstand millions of repetitions of low stress.

(5) The endurance limit for the ferrous metals tested could be predicted with a good degree of accuracy by the measurement of rise of temperature under reversed stress applied for a few minutes. This relation is explicable in view of the intercrystalline and intracrystalline slippage under repeated stress shown by the microscope. It is believed that this test, which is a development of a test proposed by Mr. C. E. Stromeyer, can be developed into a reliable commercial test of ferrous metals under repeated stress. Its applicability to non-ferrous metals has not been investigated.

(6) Abrupt changes of outline of specimens subjected to repeated stress greatly lowered their resistance. Cracks, nicks, and grooves caused in machine parts by wear, by accidental blows, by accidental heavy overload, or by improper heat treatment may cause such abrupt change of outline. Shoulders with short-radius fillets are a marked source of weakness.

(7) Poor surface finish on specimens subjected to reversed stress was found to be a source of weakness. This weakness may be explained by the formation of cracks due to localised stress at the bottom of scratches or tool marks.

(8) Stress above the endurance limits, due to either a heavy overload applied a few times or a light overload applied some thousands of times, was found to reduce somewhat the endurance limit of two ferrous metals tested.

(9) In none of the ferrous metals tested did the endurance limit under completely reversed stress fall below 36 per cent. of the ultimate tensile strength; for only one metal did it fall below 40 per cent., while for several metals it was more than 50 per cent. However, these metals were to a high degree free from inclusions or other internal defects; the specimens had no abrupt changes of outline, and had a good surface finish.

(10) It is well known that subjecting steel to a stress beyond the yield point raises the static elastic tensile strength to a marked degree. The effect is less marked on the endurance limit, although some increase was observed for 0.18 carbon steel with the surface polished after being stretched well beyond the yield point. Annealing of commercial cold-drawn screw stock was found to lower its endurance limit somewhat less than it did its static elastic strength.

(11) The test results herein reported indicate the effectiveness of proper heat treatment in raising the endurance limit of the ferrous metals tested. Here again it should be noted that an increase in static elastic strength due to heat treatment is not a reliable index of increase of endurance limit under reversed stress.

(12) The phenomenon known as "fatigue" of metals under repeated stress might better be called the "progressive failure" of metals. The most probable explanation seems to be that such failure is a progressive spread of microscopic fractures. A nucleus for damage may be a very small area of high, localised stress, due to a groove, a scratch, or a crack; in other cases failure may be due to internal inclusions or irregularities of structure; it may be due to internal stress remaining after heat treatment; it may be due to a grain or group of grains unfavourably placed to resist stress; or failure may begin in the weaker grains of a metal whose structure consists of two or more kinds of grains; or it may, of course, begin in any portion of the metal which, by accidental overload or otherwise, is stressed to the yield point.

A New Two-stroke Cycle Engine.

We have received from the Low Engineering Co., Limited, of 92, High-street, Kensington, particulars of an interesting two-stroke cycle engine which has recently been produced experimentally, and having run successful trials, is now ready for actual production. In designing it the inventor has sought to retain the essential advantages of the two-stroke motor, while avoiding certain disadvantages and difficulties which are met with in some already existing designs. At the same time, with a view to simplifying production and reducing first costs, the employment of castings which necessitate especial care in the foundry has been avoided, and machining and erection have been made as simple as possible.

It is well known that in designing a successful two-stroke engine, the most important factor is the correct determination of the port areas, so that the resulting gas velocities may enable the operations of scavenging and exhausting to be completely carried out, and the maximum efficiency to be attained. In the present instance, the port dimensions and the arrangement of the crankcase compression passages have been worked out on scientific principles, the sizes of these parts having been fixed, as the outcome of a series of experiments by Professor Low, with his synchronous cinematographic apparatus for the study of gas motions and velocities.

The model shown in the accompanying illustration—Fig 1—is of 492 cubic centimetres capacity only. It has

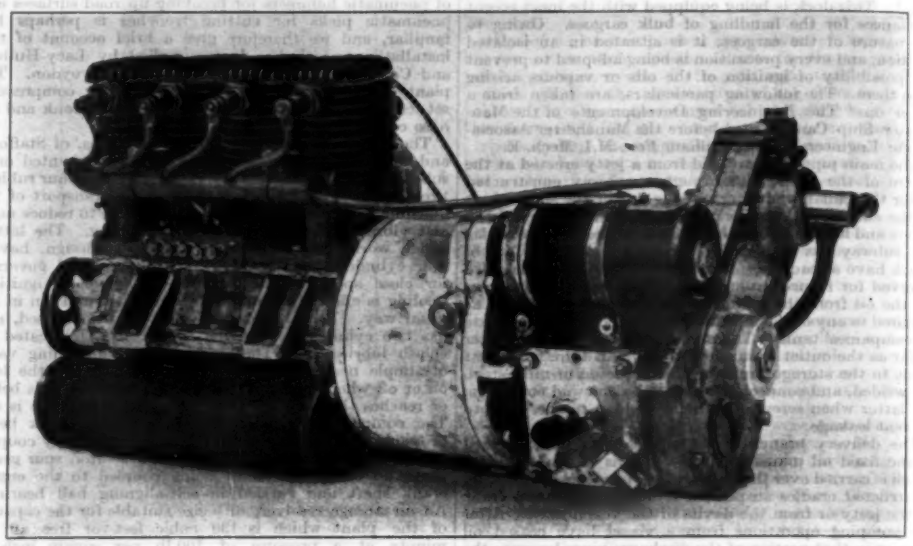


FIG. 1—10-B.H.P. TWO-STROKE CYCLE PETROL ENGINE

four cylinders arranged in a single casting, sections of which are given in Figs. 2 and 3. The bore and stroke are 52 mm. and 58 mm. respectively, and the bore to stroke ratio 1 to 1.11. The clutch and gear box are bolted directly to the engine crankcase, forming a compact unit and providing a totally enclosed transmission mechanism and flywheel. The clutch is of the multiplate Ferodo-lined type, and the gear-box has three speeds with constant mesh gate control. Clutch and gear-box lubrication is effected on the suction automatic principle. Attached to the gear-box is a dynamo positively driven by spur gears, thus avoiding belt or chain transmission troubles. High tension coil ignition is provided, a low tension distributor and contact breaker being fitted at the front of the engine—Fig 2.—and driven by skew gearing directly from the crankshaft. A sectional arrangement of the engine which shows details of the various engine parts is given in Figs. 2 and 3. The crankcase is of aluminium. The crankshaft is machined out of solid nickel steel bar, with the cranks at 90 deg., and solid discs so that a sufficiently high compression pressure may be obtained by reduction of the volume of the crankcase. The lubrication of the engine is effected under a pressure of about 4 lb. obtained

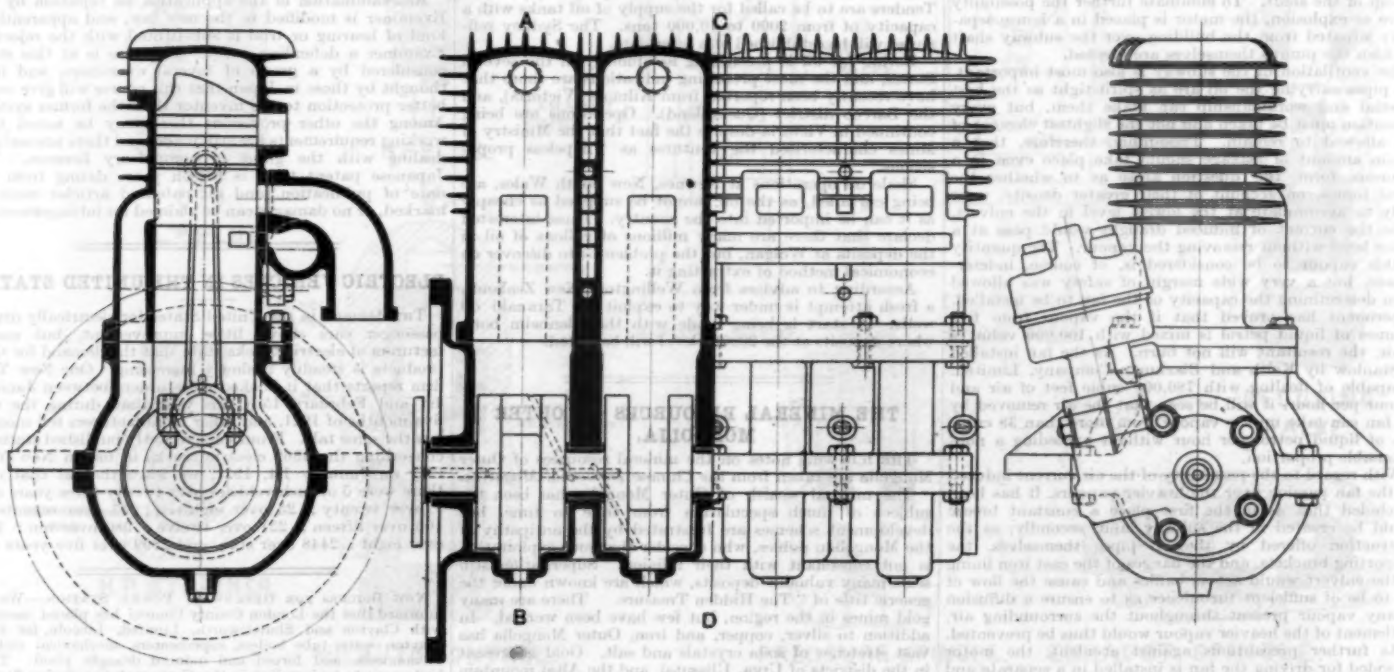


FIG. 2—SECTIONS AND ELEVATIONS OF TWO-STROKE CYCLE PETROL ENGINE

from the crankcase. A connection is made from the crankcase to the inlet pipe so that a small mist or spray is introduced into the cylinders.

Referring to section A, B—Fig. 2—it will be noted that, in addition to the sparking plug connection on the left hand wall of the cylinder, a decompression connection has been allowed for on the right-hand side of the cylinder wall. During the test it was found that decompressors were not necessary, and this connection is no longer

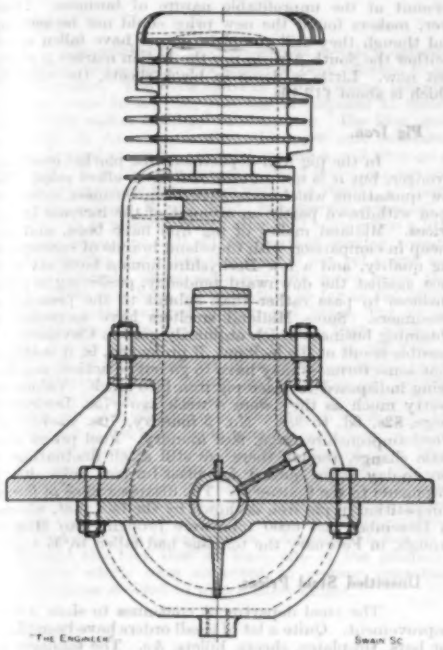


FIG. 3—SECTION ON LINE C D IN FIG. 2

required. The pistons are made from cast iron, and the crown of the piston is so shaped that the incoming charge is not broken up. In the present model, plain cast iron sand-moulded cylinders are used. A combined air and exhaust manifold of neat design cast in aluminium is bolted direct to the cylinder casting. When under test the engine developed 10 horse-power at 3800 revolutions per minute and fitted to a motor cycle frame gave an average petrol consumption of over 60 miles per gallon.

Heat Insulators.

A REPORT just issued by the Food Investigation Board of the Department of Scientific and Industrial Research, gives some valuable information on the heat insulating properties of the materials commonly used in the construction of cold storage chambers. The investigations on which the report is based were carried out at the National Physical Laboratory, and were made on a considerable scale, so that the results are of practical value. The material to be tested was placed on either side of metal plate which was kept at a constant temperature electrically, and was surrounded by a separately heated "guard ring." The guard ring was maintained at the same temperature as the hot plate, and this prevented loss of heat from the plate at its edges. On the two outer faces of the block thus formed there were clamped two cold plates and finally 6in. of cork insulation outside all. The cold plates were kept cool by circulating brine through pipe coils on their back faces, and for this purpose Messrs. J. and E. Hall, of Dartford, presented a refrigerating plant. The dimensions of the hot plates were 3ft. by 3ft., while the cold plates were 5ft. by 5ft.

It was found that with some materials such as granulated cork, convection currents affected the heat transmission considerably, and some experiments were thus made with another style of hot plate. In this case the heaters measured 14in. in length by 4in. in height, and twenty-five of them were arranged one above another to form the complete plate. The apparent conductivity of the insulating material opposite the lower heaters was far greater than that higher up, on account of the heat carried upwards by convection, but above a height of about 16in. the conditions were fairly constant. When horizontal cardboard baffles were arranged in the cork between the heaters convection losses at the bottom were naturally reduced, but the total amount of heat passing throughout the height of the specimen was approximately the same as before the baffles were introduced.

The principal experiments were made with the 3ft. square hot plate, and covered a large variety of materials, such as cork, slag wool, charcoal, diatomaceous earth, wood, eucalyptus fibre, bitumen flooring composition and concrete blocks. The thermal conductivity of slab cork ranged from 0.295 to 0.339 B.Th.U. per square foot per hour for 1in. thickness and 1 deg. Fah. difference in temperature. For granulated cork the conductivity lay between 0.295 and 0.345 according to the density with which it was packed. Slag wool was best at 0.290 when packed 21 lb. per cubic foot, and worst at 0.422 for a sample deteriorated by vibration. Charcoal was fairly constant, when dry, at 0.348 units, but diatomaceous earth varied from 0.560 to 0.662. Pitch pine wood gave the value of 1.036, and concrete blocks 8.2.

In conclusion, Dr. Griffiths says:—"Cork, slagwood, charcoal and wood fibres, when of good quality and dry, have practically the same thermal conductivity, viz., 0.00011 gm. cal. per second per centimetre per 1 deg. Cent. [= 0.32 B.T.U. per square foot per hour for 1in., and for 1 deg. Fah. difference]; judging from the fact that such entirely different materials are about equally good as insulators, it would appear that their resistance to conduction is not very far from the limiting value that is practically obtainable by subdividing the air space. In this connection it is of interest to note that still air has a thermal conductivity of only 0.00005 C.G.S. units [=0.14 B.T.U. per square foot per hour for 1in. and for 1 deg. Fah. difference] or barely half that of the best of these materials, so there is still a margin for improvement by finding a more suitable material in cellular form. Different brands of cork, &c., vary slightly in their efficiency as insulators, but it may be stated as a general conclusion that with samples of good quality such differences are not very considerable, and the extravagant claims which are sometimes made in advertisements by vendors of insulating materials are devoid of foundation. It is clear that the thermal conductivity of materials in general such as cork is not an invariable physical constant like the thermal conductivity of pure metals. It follows that it is advisable to test samples of various consignments just as it is desirable to determine the calorific value of a fuel or any other commercial commodity. Materials that are liable to deteriorate in use decrease in efficiency as insulators in consequence of such change and the tests indicate that the decrease may be quite considerable. Coarse granular materials permit of the circulation of convection currents in the material which complicate the phenomenon of the heat transmission.

Since the above report was written another material of great promise has been brought to the notice of the Committee. It consists of rubber expanded by gas into a highly cellular form. When viewed under a low power microscope the material shows a structure made up of minute cells bounded by rubber membranes. This results in an exceedingly light solid of density varying from 0.059 to 0.12 (3.7 lb. to 7.5 lb. per cubic foot). The air cell structure with thin boundary walls of low conductivity material is the ideal one for heat insulation and, from the results of the preliminary experiments quoted below, it will be seen that the conductivity of this material is about 0.000085, which is lower than that of cork or of any other substance studied in the course of this investigation, being only one and a-half times that of still air. The practical importance of this result is all the greater from the fact that the weight of the cellular rubber is only about half the weight of an equal volume of slab cork. A sample of spongy rubber was also obtained which, it was stated, was used for upholstery work. This material was volume for volume considerably heavier than the cellular expanded rubber. It weighed 14 lb. per cubic foot and its conductivity was greater than that of cork (0.00013 as compared with 0.00010 to 0.00012 for various samples of cork).

The methods of manufacturing the two materials appear to be quite different. The cellular expanded rubber is prepared by vulcanisation under high gaseous pressure amounting to as much as a hundred atmospheres. The pressure is gradually released during the cooling down stage, and this results in an expansion of the gas distributed through the rubber, giving a very light product. The spongy rubber, on the other hand, is prepared by vulcanising rubber mixed with ammonium carbonate. On being heated the salt decomposes and, in escaping, it breaks a passage through the rubber. This gives a product which is porous and absorbent, in sharp contrast to the cellular expanded rubber in which the cells are unbroken.

Copies of the report, price 3s. net, are obtainable from H.M. Stationery Office, Imperial House, Kingsway, W.C. 2.

The Utilisation of Steam.

A FURTHER report has recently been published by the French Committee which is studying the question of how best to utilise fuel. The author, M. Kammerer, discusses at some length the various ways in which steam is used in industry, and states the principles involved and the present ascertained knowledge as to the best means of attaining economy and efficiency. At the outset M. Kammerer remarks that in the study of the problem in hand, we are concerned not only with the heat content of the steam, but also with its heat quality, including in this latter term such characteristics as pressure, temperature, degree of saturation, and superheat. In a section devoted to the transmission of steam, the author calls for more attention to be given to the question of steam velocity where steam is used for heating purposes and quotes the figures of from 30 m. to 50 m., or say 100ft. to 160ft. per second, as a useful working basis. In the case of steam for power requirements greater consideration should, he contends, be given to the design of pipe lines, and the avoidance of all sharp bends or sudden changes in section. Losses may also be reduced by fitting valves of the modern straight-through type. Dealing with prime movers, M. Kammerer states that with new single-cylinder condensing engines a consumption of 7 kilos., or 15.4 lb., per horse-power hour of saturated steam should be obtained, whilst with double expansion condensing engines the consumption may vary from 5.5 kilos. to 6 kilos., or 12 lb. to 13 lb. Where superheated steam is used these figures may be reduced by 13 per cent., whilst in the case of engines exhausting to the atmosphere an increase of 20 per cent. to 25 per cent. or more may be expected. Two tables are given showing the influence of the variation of the initial and final cylinder pressures on the theoretical consumption of an engine, and a further table is added showing the variation in consumption with differing degrees of superheat. M. Kammerer points out that from the figures given in the first table it appears that for condensing engines there is no particular gain in raising the initial cylinder pressure above 16 kilos. to 18 kilos. per square centimetre or 225 lb. to 250 lb. per square inch. This statement does not of course apply to engines working against a back pressure.

The question of cylinder condensation is touched upon and cylinder jacketing is recommended. Discussing steam turbines, M. Kammerer points to the ability of the steam turbine more economically to utilise the energy of steam at low pressures, and the desirability of employing as high a vacuum as possible is emphasised. Figures are quoted showing that between 80 per cent. and 95 per cent. vacuum there is a reduction of from 1 to 2 per cent. in consumption for every per cent. increase in vacuum. In concluding this section of the report, the author calls attention to the smaller consumption obtained with large sizes of units, especially where high initial pressures are adopted.

The general use of steam for drying and heating in manufacturing processes is briefly considered. In this connection emphasis is laid on the economy obtainable by the use of higher temperatures where conditions allow, particularly when hot air is used as the heating medium. Thus the quantity of heat necessary for the evaporation of a kilogram of water is 763 calories with air at a temperature of 70 deg. Cent., and with air at 30 deg. Cent. the same operation requires 1260 calories. M. Kammerer deals at some length with the use of mixed pressure and back pressure turbines in conjunction with steam accumulators, pointing out the economy gained in a well-designed installation where the need of steam for motive power on the one hand and the steam required for industrial processes on the other hand are properly balanced. The advantages of heating by exhaust steam at low pressures are also dealt with. At the end of the report a short section discusses the process of evaporation and concentration under vacuum, and the author puts forward the suggestion that just as vacuum is used to lower the boiling point of the liquid which is being concentrated, so compression might well be utilised to raise the temperature of the steam given off from the liquid and thereby enable it to be more effectively used for re-heating. This process of compression suggests the idea of a new use for hydro-electric energy for the thermal operations of evaporation and concentration, in a way more advantageous than by the direct transformation of electrical energy into heat energy. Here is an extremely interesting use for the surplus hydraulic energy which is available, for instance, during periods of light load in the night.

In concluding his report, M. Kammerer remarks that the consideration of the combined problem of steam for motive power and industrial processes which takes very varied forms will undoubtedly mean widely modifying the types of plant now in use. It is very necessary, he urges, that engineers and constructors should design any given installation or factory from the point of view of overall efficiency, and to attain that end both machinery and apparatus must so be adapted as to use pressure and temperature falls to the best possible advantage. It is also desirable, he adds, that the industries should provide the necessary funds to make these complete schemes possible; progress along these lines, apart from any particular interest, forwards the national interest by facilitating output and making possible reductions in price. By this means the French nation will be better enabled to meet foreign competition, where perhaps, although better coal conditions exist, research on fuel saving is not so far advanced. It is important, he concludes, that French industry should not be allowed to go back.

Shale Oil.

ALTHOUGH there has been a shale oil industry in Scotland since the days of James Young, in the middle of the last century, it is only within the last few years that much interest has been shown in the vast deposits of shale in other parts of the world; and this interest has necessarily been stimulated by the almost desperate search for new sources of fuel in any shape or form. The production of shale oil on a commercial scale has hitherto suffered, like alcohol from cellulose, under the serious disadvantage of comparatively small yields from a great bulk of raw material. The amount of material to be handled for an output of oil worth considering is enormous, involving a correspondingly large plant and heavy outlay for labour, as well as space for dumping the waste. There are, however, certain natural conditions, such as those which obtain in Colorado, where there is unlimited space for dumping and where the shale formations occur in such a way, *e.g.*, in cliffs and hills, that gravity can be utilised to a much larger extent than would be possible on the level. During the last year or two a great deal of valuable research in connection with oil shales has been carried out by the Colorado School of Mines, some of the results of which have been published. An interesting development is the attempt being made to find some use for the spent shale, namely, in brick-making and in the manufacture of cement. Since the spent material consists largely of clay, with appreciable proportions in many cases of potash, lime, and nitrogen, it could be spread over the land and used as ordinary soil. A further suggestion in America is to use it for making railway sleepers, for which purpose it is claimed to be better than cement.

A still more important development in oil shale technology has been recently reported from Australia, whereby the cost of production should be very considerably reduced. It is well known by now that the shale deposits in New South Wales are practically inexhaustible, and a new company, the Oil Shale Products and Coal Company, is now working at Joadja, producing 700 gallons of crude oil per week, but it is hoped to increase this output to 15,000 gallons a day before the end of this year, for the work is still in the experimental stage. The best quality shales at Joadja give the exceptionally high yield of 180 gallons per ton, whilst the minimum yield seldom goes below 80 gallons. In another part of New South Wales—the Wolgan Valley—the Commonwealth Oil Corporation proposes, according to the *Australian Mining Review*, to test a scheme devised by its manager, Mr. John Fell, in which retorts will be done away with altogether. The idea of burning the shale *in situ* is not new, but the successful carrying out of this idea on a large scale would undoubtedly be novel. Portions of the shale have been already fired, the idea being to make the valley a vast natural retort, the gas produced being used in gas engines for generating electricity. It is believed that the whole of the shale could be burnt in this way without any waste or danger.

Another report, dealing with the Esthonian deposits, has just been issued by the United States Department of Commerce. These deposits are estimated to contain at

least 1,500,000,000 tons of shale, known locally as "kukersit," mostly near the surface and obtainable by open cut work. The present Government of Esthonia is giving particular attention to the exploitation of this field. Numerous attempts have been made to use the shale in the raw state as fuel, but not very successfully, owing, it is said, to the large amount of ash. The chief centre of activity is at Kochtel, where there is a central power station, and where steam shovels have lately been installed for expediting the work. Experiments are being carried out to evolve the most efficient form of retort. The Esthonian shales contain up to 62 per cent. of hydrocarbons and a fairly high percentage of sulphur, up to 2.5 per cent. In its anxiety to hasten developments, the Government has granted numerous concessions to foreign syndicates, including one to a syndicate with headquarters in London, for 2400 hectares, and one to another British firm for 2500 hectares. A Belgian syndicate has obtained a concession over 10,000 hectares, with the right to lay a pipe line for the oil from Kohla to Baltic ports. A still larger concession of 13,500 hectares is being negotiated by British interests. A local firm, the Northern Paper and Cellulose Company, controlling a large area of shale, is constructing railways and buildings for the purpose of producing shale oil on a large scale.

INSTITUTION OF MECHANICAL ENGINEERS.

LIEGE AND PARIS MEETING, 1922.

L'ASSOCIATION DES INGENIEURS SORTIS DE L'ECOLE DE LIEGE is organising an International Scientific Congress and Exhibition to celebrate the seventy-fifth anniversary of the foundation of the Association, and an invitation has been received by the Institution of Mechanical Engineers for members and ladies to attend and take part in these celebrations. As the present year also marks the seventy-fifth anniversary of the foundation of the Institution of Mechanical Engineers, the Council has decided that a portion of the Summer Meeting this year shall be held in Liége in conjunction with the Liége Association, the remainder of the meeting being held in Paris. La Société des Ingénieurs Civils de France and other friends in Paris have expressed their cordial approval of this proposal, and have intimated their desire to do everything in their power to ensure the success of the meeting. Invitations have already been received for members to visit some of the large works in and around Liége and Paris. The following outline programme, which is subject to revision, has been drawn up in conjunction with the Liége Association, the French Society and others :—

PROVISIONAL OUTLINE PROGRAMME.

Saturday, June 10th.—8.30 a.m.: London depart for Liége, arriving at 8.9 p.m.

Sunday, June 11th.—Afternoon: International Congress and Exhibition organised by the Liége Association of Engineers, reception of official delegates and guests; official opening of the Exhibition.

Monday and Tuesday, June 12th and 13th.—Mornings: Meetings in conjunction with the Congress; visits to works. Afternoons: Visits to the Exhibition and to works. Evenings: Social functions.

Tuesday, June 13th.—2 p.m.: London depart for Amiens, arriving at 7.37 p.m.

Wednesday, June 14th.—Morning: Visit Amiens Cathedral and the town. Luncheon. Amiens depart by motors for Compiègne, traversing the devastated areas *vid* Villers Brettonneux, Chaulnes and Noyon, and joining the main party at Compiègne.

Wednesday, June 14th.—7.15 a.m.: Liége depart for St. Quentin. 11.30 a.m.: St Quentin arrive. Luncheon. St. Quentin depart by motors for Compiègne, traversing the devastated area *vid* Ham, Roye and Noyon. Dinner in Compiègne. 9.30 p.m.: Compiègne depart for Paris, arriving at 10.42 p.m.

Wednesday, June 14th.—11 a.m.: London depart for Paris, arriving at 6.25 p.m.

Thursday, June 15th.—Morning: Meeting at the Société des Ingénieurs Civils de France, reading and discussion of papers. Afternoon: Visits to works. Evening: Institution dinner.

Friday, June 16th.—Morning: Meeting at the Société des Ingénieurs Civils de France, reading and discussion of papers. Afternoon: Visits to works.

Saturday, June 17th.—Whole-day excursions to places of interest in neighbourhood of Paris.

Sunday, June 18th.—Excursion on the Seine.

Monday, June 19th.—Morning: Paris depart for England.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, the 6th inst., Sir James Crichton-Browne, Treasurer and Vice-president, in the chair. Miss A. Bagot, Mr. W. V. Ball, Miss E. J. Blunt, Mr. S. B. Donkin, Mr. R. E. Gibbs, Mr. G. N. E. Hall-Say, Mr. H. A. Hankey, Miss A. M. Herron, Mr. D. Lucas, Sir Murdoch MacDonald, Mrs. Aylmer Lloyd, Mrs. Reginald McKenna, Mr. H. B. Moberly, Mr. G. S. Odling-Smee, Mrs. W. Carpenter Scott, Mr. R. Seligman, Mrs. Sharman-Crawford, Professor G. Elliott Smith, Dr. A. Stanley, Mr. C. F. M. West, and Mr. E. Yatman were elected members.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS (INCORPORATED).—The following is a list of the officers and members of council of the Institution of Railway Signal Engineers for the current session :—President: Mr. W. C. Acfield (Derby); past presidents: Messrs. A. T. Blackall (Reading), J. Sayers (Derby), A. Hurst (York), and C. H. Ellison (York); vice-president: Mr. R. J. Insell (Reading); hon. treasurer: Mr. A. E. Tattersall, signal superintendent, Great Northern Railway, King's Cross: council: Messrs. R. G. Berry (Hunt's Bank, Manchester), J. Boot (Wimbledon, S.W.), A. F. Bound (Guide Bridge, Manchester), C. Carslake (Guide Bridge, Manchester), C. J. Cooke (King's Cross, N.), F. Downes (Retford), W. S. Every (Earl's Court, S.W.), E. F. Fleet (York), R. H. Houghton (Victoria, London), H. E. Morgan (Derby), C. W. Neele (Marylebone, London), H. M. Proud (London), J. Punter (London), J. T. Roberts (Crewe), A. F. Rock (Stoke-on-Trent), and W. J. Thorrowgood (Wimbledon, S.W.); hon. auditors: Messrs. F. L. Castle and W. E. Sowter; hon. secretary: Mr. M. G. Tweedie, Great Western Railway Signal Department, 80, Caversham-road, Reading.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

The Engineering Trade Crisis.

THE crisis which has arisen in the engineering industry affects no fewer than 15,000 men in the Birmingham district, which includes Wolverhampton and other Black Country towns. The membership of the Amalgamated Engineering Union in this area nominally approximates 90,000. Of that number 5000 are now unemployed, while the membership of a considerable proportion, it is stated, has definitely lapsed. Out of some 1500 firms in Birmingham and district a little over a third are federated with the National Engineering Employers' Association, and in this district the non-federated firms—to which the notices do not apply—are among the most important. It is as yet too early to attempt an estimate of the effect of the stoppage so far as the Birmingham area is concerned. At all the principal works—the B.S.A., Wolseley, Austin, Tangyes—and at the large electrical works, the members did not present themselves on Monday. Nevertheless, the firms in the Federation have been able to carry on up to the time of writing because there are men in kindred unions doing precisely the same work as A.E.U. members, and there is a considerable number of mechanics who are not members of the union. Mr. Alexander Ramsay, of the Employers' Federation, stated this week that during the past week many men had come to the employers intimating that they have resigned from the A.E.U. and had asked to be kept on. It is realised by master engineers here that a few men in the other unions may refuse to work out of their sense of loyalty with their A.E.U. colleagues, but there may be easily as many ex-A.E.U. men ready to stay at bench and machine. It is understood, too, that it is not the intention of the officials of the A.E.U. to call out any of their members engaged in works at which notices have not been posted. It is declared by the officials of the A.E.U. that many engineering firms in the Birmingham district do not belong to the Engineering Employers' Federation, and that consequently there will be no complete stoppage. The Federation, on the other hand, maintains that the number of firms remaining outside is small, and that the fact that these firms which acknowledge no formal allegiance to the Federation will not affect the ultimate result. Moreover, they claim that such a large proportion of the trade union membership has lapsed that the engineering firms will be able to draw upon a considerable number of men who are not now bound to obey the orders of the union. So that, it is contended, the federated firms will also be in a position to carry on without the aid of union labour. At the moment it is impossible to judge the value of the varying contentions. Less than a thousand men are affected at Wolverhampton, as most of the big firms belong to a local employers' union which so far is not involved.

What a Prolonged Stoppage Would Mean.

The engineering industry is one of vital consequence to the nation. From some departments of industry it takes, as its raw material, their finished products. To others it supplies the tools they need for their work. A prolonged stoppage must be disastrous all round. The more so because it would eventually involve industries which at the moment are unaffected by the lock-out. Its immediate consequences may not be so obvious to-day as in a period of boom trade. But it must inevitably postpone any signs of reviving trade, and if it is prolonged it may cost us foreign markets we are now striving to regain. The engineering employers are fighting for the right to carry on their business in accordance with their own judgment, and against the attempt "to establish a dual administrative control in the shops." Overtime is only one of many instances in which shop stewards—going far beyond the claims of their own union leaders—attempt to control managements. It is the Communists within the union who have made this management question acute. And the Communists, outside the union, are ready now to use the trouble for their own political ends. The consequences of the stoppage to this district are only dimly visualised. Some producers of iron and steel think the effect will take some time to make itself felt, and that although trade will inevitably suffer, the iron and steel industry will not be crippled unless the conflict is of long duration. In the iron trade the chief department to be influenced will be that of pig iron, just now showing encouraging signs of recovery. Engineering concerns will not be inclined to place orders for pig iron until things have settled down again. Ironmasters point out that their workpeople have sustained heavier reductions than are now called for either from shipbuilders or engineers; yet, owing to the operation of wages boards and sliding scales, friction has been avoided. At Coventry, where at present trade in the city is best described as patchy, optimism is naturally tinged with anxiety; but manufacturers generally are concentrating more and more on the seasonal trade, and this week, despite the lock-out, more encouraging reports are to hand and there are evidences that the position will improve. Altogether there are 14,000 engineers in the city, but only about 8000 men ceased work last week-end.

The Staffordshire Bar Iron Trade.

The Staffordshire bar iron trade is still sluggish, except in the lower grades of unmarked bars. Marked bar mills continue to pursue a fairly even course, undisturbed by outside competition. Better reports are forthcoming of sales of the class of second-grade iron used in the bolt and nut trade, not because of a revival in that industry, but rather by reason of the fact that the low-level prices have reached warrants purchased for stock. For a good order for nut and bolt iron sellers are prepared to shade the recently quoted price of £10 15s. per ton. This does not apply to the fencing trade, which is reverting to the use of iron, the quotation here being £10 15s. firm to £10 17s. 6d., according to specification. The prices of bars quoted locally appear to be entirely above market ideas, and steel is increasingly preferred, obtainable round about £9 5s. If bar iron be excepted, there is hardly any class of material which cannot now be bought as cheaply at home as from the foreigner. No. 3 bars can be imported from Belgium at £9 10s., but they are not being bought to any extent. The competition for the district trade remains between Staffordshire and Lancashire makers. Iron tube strip finds a slow sale at £12 10s. Galvanised corrugated sheets have receded to £16 for a good line, ranging to £16 5s., makers being unable to maintain the recent advance to £16 10s. f.o.b. which, they stated, became necessary on account of the unprofitable nature of business. However, makers found the new price could not be secured, and though they still complain, prices have fallen again. Neither the South African nor the Indian market is strong just now. Little is doing in black sheets, the price for which is about £12 10s.

Pig Iron.

In the pig iron department the market continues stronger, but it is not an easy matter to effect sales. The low quotations which were unsettling business have now been withdrawn partly on account of the increase in fuel prices. Midland makes of pig iron have been, and are, cheap in comparison with Cleveland brands of corresponding quality, and a few Derbyshire houses have set their face against the downward tendency, preferring to allow business to pass rather than submit to the pressure of consumers. Some Midland smelters have succeeded in obtaining business which ordinarily goes to Cleveland. A possible result of the lock-out, if prolonged, is, it is stated, that some furnaces may have to go out of action, smelters being indisposed to place pig iron into stock. Values are pretty much as they were a week ago—75s. Derbyshire forge, 82s. 6d. to 85s. No. 3 foundry, 70s. to 72s. 6d. Northamptonshire forge, 80s. foundry. Fuel prices show little change, though there are still small fluctuations in day-to-day rates quoted for blast-furnace coke due to shipments to the Continent. The disappearance of foreign competition in pig iron is shown by the fact that, whereas in December last 6000 tons were brought into Middlesbrough, in February the tonnage had fallen to 34 tons.

Unsettled Steel Prices.

The steel department continues to show a little improvement. Quite a lot of small orders have been placed for bars, tin-plates, sheets, billets, &c. The tonnages are also better than they were, representing quantities running into hundreds of tons, whereas a few weeks ago from 10 to 20 tons was the usual limit. The material is wanted largely for stamping and working-up purposes and indicates a certain amount of general trade revival. But under the post-war capacity for mass production much heavier business is wanted. Very fair sales of steel have been made by Birmingham merchants. Billets are a turn stronger, ruling at £7 10s. and upwards. This shows an increase on the week of 5s. per ton. Welsh steel concerns also demand £7 10s. for delivery in this district, as compared with £7 5s. a fortnight ago. Small steel bars are cheaper, having dropped 10s. during the week. They are now quoted at £9 per ton. Unassociated houses do not feel themselves bound by the re-declared prices for sections and plates, but it is difficult to-day to get concessions from any steel maker. Business in Staffordshire steel hoops is still done at £12. America is a keen inquirer as to business possibilities, being very desirous of a share of British orders. On some products, including steel strip, it is thought they may be able to undersell British makers, particularly as the value of sterling in New York continues to improve. There are at present no continental offers of steel, with the exception of some wire rods from Antwerp, which are believed to be of German origin and are obtainable at slightly below home prices.

Wire Prices Reduced.

A reduction of £3 per ton is announced in galvanised, coppered, tinned, and half-round wire, making the basis £21 for the two first-named, £32 for tinned, and £27 for half-round catch-weight coils, with £2 extra for exact 1 cwt. or ½ cwt. coils. The reductions do not apply to bright round steel wire, which remains unaltered at £18. While Belgian wire rods are nominally dearer this week at £12, that price is not adhered to where an order can be got by shading it. The home price is £11 10s., the gauge being larger, however.

Astonishing French Returns.

The facts revealed by the foreign trade returns of the French iron and steel industry for the past year astonish iron and steel industrial circles here, and afford an opportunity for serious reflection. The official French returns show that the total exports of iron and steel in 1921 amounted to 2,091,000 tons, as compared with 1,246,000 tons in 1920. The most remarkable fact, however, is that the exports last year were more than double those which prevailed in 1913, when the tonnage sent out of the country reached 1,008,000 tons. The subject of discussion is, if it has been possible for the French works almost to double their exports in a year of depression, as contrasted with 1920, and to more than double them as compared with 1913, what may be expected when the general situation begins to improve and the French begin to utilise more of their undoubtedly large capacity of production, assisted by cheap supplies of German coal and German coke, which are delivered at the German inland prices according to international agreement.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER, Thursday.

Iron, Steel, and Metals.

THE markets for iron and metals are all extremely depressed here, and very little business is now going on in the Manchester market. It is noticeable that the attendance on the Exchange has fallen away, but this is not surprising in view of the general position, for one

might hunt through the market without finding anyone who wanted to buy anything. Of course, there must be an accumulation of work which will have to be executed later on; but one fears that a good deal of business will be lost to the country and perhaps will never come back again. The general situation in Manchester is perhaps worse than in other parts of the country, for Manchester is a great engineering centre. As a matter of fact, the trade here has never properly recovered from the effect of the prolonged moulders' strike, and is in no condition to stand a dispute such as has now been forced upon it.

Metals.

The market for the non-ferrous metals is naturally very quiet, but so far prices have not been affected to any serious extent. The little spurt in copper seems, however, to have come to an end, and one is disposed to believe that it was rather artificial in character. The idea, quite prevalent in America, is that if copper can be started on an upward move by artificial means it will then go on by itself. It is like galvanising a dead body into activity and then expecting it to move about by itself; although, of course, copper is not dead, but merely comatose at present. It is possible that a time will come when a little judicious stimulant will set the market moving towards a more healthy state, but this time is not yet; and as a rule prematurely given stimulants do more harm than good. There has been no alteration so far in the official prices for manufactured copper and brass, but as the market seems again inclined to go down there would, of course, be no call to raise these prices. In the end, of course, all of them must be more closely adjusted to the values current for raw metals, and if copper and tin were to advance by £20 per ton some of these prices would still be too high. It is possible that the slump in the engineering demand for tubes may bring about a modification in the prices now charged, for the combines cannot have much power outside this country. It is anticipated that the American domestic demand for copper may be only small for some time to come, as a good deal of forward buying has taken place, which should provide for a fair proportion of the future needs of consumers. Against this has to be mentioned the fact that at least one of the producing companies which were expected to resume operations next week has decided to wait a little longer.

Tin.

The price of tin has recovered a little, but the market seems rather unsteady. The continental demand has not recovered, and the Welsh tin-plate trade has not been doing very much. There is a feeling that the chemical trade strike in Wales may soon affect the supplies of acid to the tin-plate trade, and bring some of the mills to a stop. This is, however, conjecture only at present. The visible supply of tin continues to be large, and behind it are the unsold accumulations of the Federated Malay States Government. These may not be offered for sale at such a tremendous loss as is indicated by present prices. Lead has remained steady without much alteration in the position. There are ample supplies of lead and no possibility of any scarcity for the present, although it is true that the strikes or labour troubles in Spain may limit shipments from that country. Spelter also is steady, and while there is no great demand, continental spelter is not pressed upon this market.

Pig Iron.

The market here for foundry pig iron—and, indeed, for all other kinds—is very quiet and dull. The demand previously to the lock-out in the engineering industry was just sufficient to keep the blast-furnaces clear of their output in the Derbyshire district, in view of the fact that there was no competition from North Lincoln or North Staffordshire iron, but one does not see how this can continue while the engineering stoppage prevails. The total output of pig iron in February was only a trifle more than that of January; although it was generally supposed that this output had increased. It is, however, not much more than 25 per cent. of the normal output, but even this will be too much now. The interesting question is whether the present unfortunate conditions will hasten the re-establishment of the warrant market. Some tentative attempts have already been made in this direction. The export demand for pig iron remains fairly good, and the high prices on the Continent continue, so that some relief may be obtained from the congestion which would otherwise result from the stoppage in the consumption. Manchester prices for No. 3 foundry pig have not been affected, and the quotation here for Derbyshire iron remains at 92s. 6d. to 95s. per ton delivered. There is, however, no longer any talk of raising these prices.

Finished Material.

The cessation of the demand for engineering work is probably more awkward for manufacturers of steel than for the blast-furnace owners. They were extremely short of paying orders before, for the home trade prices were the only prices which gave a chance of a profit. No doubt efforts will be made to get more export orders with a view to keeping works open, but there is no present chance of getting those orders at remunerative prices, and one fears that some of the steel works will have to close down until better times arrive.

Scrap.

The demand for scrap seems to have ceased altogether here, unless it be a small business in heavy wrought scrap at very low prices. The ironworks may think it worth while to take in this material at £3 per ton, even if they cannot use it at once. Foundry scrap is quoted at £4 to £4 10s., and heavy steel melting scrap at £2 5s. to £2 7s. 6d., but there is practically no business.

Manchester Association of Engineers.

There was a very large attendance of members at the meeting of the Manchester Association of Engineers on Friday last to hear Mr. William Fox's paper on the "Engineering Developments of the Manchester Ship Canal." It should be mentioned that the author is the Canal Company's chief mechanical engineer—a post which he has filled since the construction of the canal. He is, therefore, fully conversant with all the mechanical and electrical problems which such a vast undertaking involves. There are many large ports having a much greater quay area than that of Manchester which handle far less annual tonnage. The directors recognise that the economical position of the ship-owning companies depends largely on the expedition or delay which occurs in connection with the handling of cargoes in dock. Being a comparatively modern port, Manchester possesses certain advantages as compared with some older ports, one of which is that it was not hampered by obsolete plant; but it is to some extent handicapped in competition with, say, Liverpool by the length of time which vessels must of necessity take in traversing the 30 miles of inland waterway with its series of locks. The utmost expedition in the operation of the locks and loading and unloading of cargoes is therefore necessary. In these respects the canal company has been well advised by its engineering staff. Every modern device which can be introduced with advantage has been adopted, and Mr. Fox's paper brought to the notice of Manchester engineers many original methods and appliances for dredging, for instance, to avoid the employment of seagoing hoppers to convey the spoil to the sea. In order to cheapen the disposal of the spoil, the latter is pumped from barges through spouting on to the land on either side of the canal, the banks of which have been raised for the purpose. Another very interesting feature which Mr. Fox alluded to was the new oil dock at Stanlow, where bulk cargoes of oil and petrol can be discharged. This dock is not yet in use, but there is no doubt that it will be a great boon to the great petroleum importing companies who will make use of it. Mr. Fox's paper was copiously illustrated by drawings and lantern slides, and will form a highly acceptable contribution to the Association's proceedings.

The Marine Engineers in the Making.

A paper with the above title was read before the Liverpool Engineering Society on Wednesday, March 8th, by Mr. Peter Youngson. The author said that there was a certain amount of truth in the jest that in America they make marine engineers principally by legislation; but that in this country the process, although slow, was very thorough, and we had every reason to be proud of the finished products. He said that the average period of apprenticeship was one of five years, between the ages of sixteen and twenty-one, and that a boy attending a secondary school did not as a rule matriculate before the age of 16–17. Employers would be willing to take him as an apprentice at the latter age, but owing to trade union regulations they could not retain him after the age of twenty-one. Mr. Youngson said that this arrangement was very unfortunate, and that it prevented many desirable boys entering the profession. They either had to break off their education at an important stage or they were unable to serve the full five years. Mr. Youngson complained that on Merseyside there was a great lack of co-ordination between the employers and the education authorities with regard to the technical progress of the apprentices. He said that only two out of the ten leading marine engineering firms asked for a report of the work done by their boys at the School of Technology, and only one firm offered any direct incentive in the form of a monetary bonus for meritorious results. He mentioned that local students were enthusiastic in their reception of the scheme of national certificates by the Institution of Mechanical Engineers in conjunction with the Board of Education.

The Lock-out.

"How long will it last?" is the question which everybody is asking in engineering circles. The answers vary, and the general opinion is that a second ballot of the A.E.U. and allied unions will pave the way to a speedy return of the men to work, for it is generally considered that the majority of the men who did not trouble to vote in the last appeal recognise the reasonableness of the masters' decision. In this district we are not concerned with the reduction of wages in the shipbuilding trade, and it is unfortunate that the two things should have been somewhat confused. I have only heard of one works of any importance in the Manchester district which has closed down as a result of the "lock-out, but all the other works in the Employers' Federation are affected in some degree. Non-unionists and apprentices are carrying on, and so are the foundrymen. It cannot be too frequently reiterated by the employers that the real issue is a refusal by a "die hard" minority of the members of the A.E.U. to recognise the employers' right to exercise managerial functions without the consent of the unions—a right which their "leaders" have already acknowledged.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is an improvement in the hematite iron trade, and the putting into blast of two more furnaces in West Cumberland is a sign of a bigger demand. Parcels of mixed Bessemer numbers are being sent to various parts of the country, and there have been shipments for the Continent. If the air could only be cleared of labour threats and lock-outs there is no doubt the trade would gradually improve all round. The inquiries are bound to be effected to some extent if the lock-out continues. Practically the whole of the pig iron ordered is for immediate requirements. The local consumption of iron for steel works in the district is fairly considerable.

Iron Ore.

The bigger activity in the iron trade is bound to be reflected in the ore trade, and the demand will increase. There is only a moderate amount being brought up at present. In foreign ore trade there is more life, and there have been importations of Spanish ores into the port of Barrow.

Steel.

The bricklayers at the Barrow works held up the rail mill, but this difficulty is now overcome and the mill is at work again. The trade generally is only moderate, but orders that are held are likely to take the works along for a few months. The hoop department is better situated. As regards the latter there are extensive additions being made, and soon the output from these works will be considerably increased.

SHEFFIELD.

(*From our own Correspondent.*)

The Lock-out.

HERE, as in other engineering centres, the dominating factor in the industrial situation at the time of writing is the lock-out. The operation of the employers' decision has not, however, so noticeably increased the ranks of workless as would have been the case in normal times, for of the 9000 members of the Amalgamated Engineering Union in Sheffield, nearly half were already unemployed before the lock-out took effect. There are in normal times about 40,000 men in the engineering industry in Sheffield and district and about 20,000 in the steel works. The Sheffield District Committee of the Engineering and Shipbuilding Trades' Federation, which represents 45,000 members, resents the fortnight's delay in the endorsement of the A.E.U. policy, and the extremists have been trying hard to extend the dispute to all the federated unions—of which there are about seventeen branches here. If this effort succeeds, it will bring the whole of Sheffield's industries to a complete standstill. The majority of these 45,000 members are, however, already unemployed, so that the spectacular effect of the extension would not be particularly noticeable. It would, however, effectually "nip in the bud" the distinct signs of revival to the existence of which I called attention last week. One of the most pronounced of these signs is the increased demand for hematite, which shows that steel makers are preparing for a larger production. The engineering stoppage has, of course, temporarily checked this movement, as it has also the improving market for ferro alloys, the demand for which has promptly responded to the smaller requirement in the tool trade. In still another direction has the dispute had an immediate effect. The steel-making firms have become overstocked with scrap, with the consequence that T. W. Ward, Limited, have had to reduce operations at a number of their shipbreaking yards. "Trade has been so bad," said a director, "that steel works have not been able to take all we were producing. We find the carrying of large stocks very costly, and there is nothing else for it but to stop a number of the works until we can reduce the stocks we have in hand."

Representations to the Government.

To-day—Friday—a deputation of representatives of the Corporations of Sheffield, Newcastle and Glasgow, accompanied by the local Members of Parliament, is to be received by Mr. Chamberlain, in the absence of the Prime Minister, to discuss the hardships resulting to the areas they represent as a result of the cancelling of the battleship contracts. The deputation is, I understand, to urge the Government to arrange for the placing of Crown Colony contracts or other alternative work in the districts which, but for the Washington Conference, would now be busy with the battleship orders. The deputation will point out how the engineering dispute has extended the distress in the munition areas, and will plead that some promise of work would put new heart into firms now faced with four or five weeks' stoppage.

Tell-tale Returns.

Sheffield steel-making firms will not derive much comfort from the Board of Trade returns for February. One of the most disconcerting disclosures is that the export of steel rails dropped from 36,191 tons in January to 18,447 tons in February; to India alone we sent 21,534 tons in January and only 3255 tons last month. Then, again, of steel girders, beams, joists and pillars, this country exported 2724 tons last month, as against 4377 tons in January, while during these two months we imported 4316 tons. Of this quantity, 2401 tons came from Belgium, though the supply from this source dropped to 890 tons last month. Total exports of iron and steel and manufactures thereof in February amounted to 223,616 tons, which was about the same as in February, 1920, and 57,000 tons more than in February last year. Our total exports of iron and steel this year have reached 476,970 tons, as against 483,545 in the first two months of 1920, and 399,249 in the first two months of last year. Our imports of iron and steel and manufactures thereof during February were 64,609 tons as against 88,727 tons in January, the total for the two months being practically the same as for February alone last year. Although, therefore, the figures for the lines in which Sheffield more or less specialises are not particularly satisfactory, the returns for the whole industry seem to indicate that the steel and iron trade generally is once more on the up grade.

The Overseas Outlook.

In the continued absence of the long-expected orders from the railway companies and the stagnation in the motor car trade, Sheffield manufacturers are looking with more eagerness than ever to the prospects of overseas business. There is a little more hopefulness in this direction, a number of moderate orders from Japan and India having been booked recently, while Australia is also buying again more freely, and Sheffield firms are hopeful of improving business relations with South America now that Germany's trade connections with that country are a little less keen. Those firms who have been exhibiting at the British Industries Fair report a far greater readiness on the part of overseas visitors to place orders—or, at any rate, to promise them—on their return to this country from Leipzig Fair, which seems to have attracted many of the prospective buyers away from the London and Birmingham Fairs after a brief inspection of these shows. Prices, on the whole, are much more favourable to British manufacturers, and

there is good ground for the belief that a very considerable proportion of the promised orders will materialise. At any rate, Sheffield exhibitors have returned home in a much more optimistic frame of mind than was the case after the previous Fair. The issue of Admiralty tenders for 20,000 razors of the fully hollow ground type and 11,000 pairs of scissors is stimulating very keen competition among local manufacturers in these departments, which of late have been experiencing a very lean time.

Refractories.

In connection with the visit of members of the Refractories Association to Sheffield last week-end, Mr. W. J. Coles, chief engineer at Edgar Allen and Co.'s works, read a paper on "Crushing and Grinding Machinery for the Refractories Industry." "There was," he said, "a growing interest in linings other than the ordinary fire-brick linings for steel and other furnaces subjected to great heat. The advance in the more scientific manufacture of refractories had brought a call for more accurate grinding of the necessary ingredients. The Germans were making great efforts to produce refractory blocks which would stand even higher temperatures than were to-day possible, and it was important that British manufacturers should not be left behind; they were, in fact, taking steps to avoid failure in this competition." Mr. Coles' challenge met with an almost immediate response from the General Refractories Company, Limited, of Sheffield, which has been devoting a good deal of research and experiment to the production of an article which will at least equal the Austrian magnesite and chrome bricks which were largely used in this country before the war. The Sheffield firm has succeeded in making a brick which is still more refractory than the Austrian article which enjoyed a high repute, and these bricks—made entirely from British materials—are even cheaper than the foreign furnace lining.

Sheffield Gas Supply.

The annual meeting of the shareholders of the Sheffield Gas Company gave the chairman, Colonel H. K. Stephenson, an opportunity to reply to the criticism with which the undertaking has been assailed lately in respect to its increased charges and poorer quality of supply. He contended that even at its present price—9d. per therm—Sheffield gas was as cheap as that of any other large industrial centre. Before the war the company was able to sell its residuals at more than the cost of the coal used in the manufacture of the gas, but that was far from being the case to-day. While the present price of gas was 200 per cent. over the pre-war figure for industrial purposes, the company was paying 250 per cent. more for its coal. Last year there was a decrease of 13 per cent. in the consumption of gas in Sheffield. Referring to recent developments, Colonel Stephenson alluded to the success which has attended the linking up of the company's system with two neighbouring colliery coke-oven plants for the utilisation of gas from these plants. That from Tinsley Park, he said, had been in operation for some few years, and recently the coke oven gas from Orgreave Colliery was also connected, and of this supply 2,000,000 cubic feet per day was now being taken. At the Neepsend Gasworks the installation of vertical retorts by the Woodall-Duckham Company was progressing satisfactorily, and it was hoped to bring these retorts into operation in August next. In order to improve supplies in the district, about 5 miles of high-pressure main had been laid, and compressors were being installed at the Effingham-street works. A good deal of trouble had lately been experienced in connection with naphthalene stoppage, which was attributed to the stripping of gas for toluol and benzol for high explosives during the war. With a view to remedying this trouble, carburetting plant had been in operation at each of the works, and further spraying apparatus had been installed at each of the works within recent weeks. Contrary to the assertions which had been made by the company's critics, the demand for industrial gas still continued, and the furnaces sold during the past year represent a total consumption of 6700 cubic feet per hour. Gas engines, he added, were also in steady demand for power purposes.

Coal and Coke.

The prospects—and eventual realisation—of the engineering stoppage had an early effect in restricting the demand for industrial fuel, but the export trade has prevented any considerable signs of weakness in the market. The local position in regard to slacks is much better than it is in many parts of the country, owing to increased usage for coke-making purposes, and on the whole prices are fairly steady, except where collieries have any large stocks under load, in which case there is a good deal of selling pressure, and in some instances price is quite a secondary consideration. Current quotations still show wide variations, but there is generally a lower tendency. The blast-furnace coke market is very strong, makers having a large number of orders on their books, both for inland and export. Prices are, however, very much easier than they were a year or so ago. Coke for crucible steel melting is selling to-day for 37s. 6d. in the case of beehive oven products, and 27s. 6d. for the patent oven coke, as compared with 70s. or more. One of the comparatively new collieries in the South Yorkshire area—Hatfield Main—on which over half a million capital has been expended, is now entering on a revenue-earning era, with a weekly output of over 4000 tons.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Engineering Crisis.

THE crisis in the engineering trades brought about by the attitude of the Amalgamated Engineering Union will have a very serious and far-reaching effect upon the industrial position in the North of England. It has occurred just at a time when there was a perceptible brightening of the general industrial and commercial situation after a severe period of depression, and has rudely upset the hopes that were confidently held of a progressive improvement in the near future. The number of men on the North-East Coast affected by the lock-out, who are members of the Union, is between 11,000 and 12,000. In the allied trades the number is much larger, totalling approximately 30,000, but these are not affected by the dispute, and the works are being kept open for these men so long as work can be found for them and until a definite decision is reached in regard to the allied trades. While in this district there are several firms not in the Federation, the number of men employed is small compared with those in the federated shops. The immediate effect of the crisis so far as the engineering trades in this area are concerned will not be extremely severe, because most of the establishments have been short of work for some considerable time past and short time has been the general rule. The serious feature, however, is that any hope of securing new business is wiped out entirely. In fact, the very rumour of the possibility of a stoppage sent much valuable work to the Continent.

Cleveland Iron Trade.

The engineers employed in the iron and steel works are working as usual, but the lock-out, if it should unfortunately be prolonged, will have a disastrous effect on the industry. Already the demand, especially for foundry iron, is falling off, and although makers are well sold for the current month, there is a growing feeling of apprehension as to the outcome of this new labour war. Another blast-furnace has been put into operation this week at the Newport Ironworks of Sir B. Samuelson and Co., Limited, but as an offset to this is the news that the Tees Furnace Company proposes to damp down the only furnace it has in blast. The Cleveland ironmasters have long claimed that they were producing at a loss, and as there seems no prospect of an early reduction in working costs, the Tees Furnace Company have evidently come to the conclusion that it will be cheaper to keep the works idle. With these changes there will be on the North-East Coast fourteen furnaces producing hematite, as against only six producing foundry iron, five on basic iron, and four on ferro-manganese and speigel—a total of twenty-nine. This is six more than were operating at the end of last year, but twelve fewer than the number in blast when the coal strike commenced on April 1st. It is now difficult to get prompt iron, and prices are firmly held, No. 1 and siliceous iron being 95s.; No. 3 G.M.B. Cleveland, 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 82s. 6d.; and mottled and white, 75s.

Hematite Pig Iron.

There has also been a drop in the business for East Coast hematite pig iron, but this is probably due to the fact that the buyers have been scared off by the continued high price. The general market quotation for mixed numbers is 100s., but West Coast hematite—usually 10s. per ton dearer—can now be bought at 97s. 6d., and buyers are consequently not so keen. Still, makers with good order books are not pressing sales, although possibly they might shade 100s. for forward business.

Iron-making Materials.

The foreign ore trade is almost lifeless. Consumers regard 27s. as too much for best Rubio ore, c.i.f. Tees, and what little business there is being done is in other ores, which are relatively cheaper. The temporary squeeze in tonnage has ended, and boats are freely obtainable, but freights are very little easier. The coke market is very firm. Attempts to bear the market have failed, and for good furnace qualities 30s. per ton is now the ruling figure.

Manufactured Iron and Steel.

The uncertainties of the labour situation have accentuated the gloom in the manufactured iron and steel trade. There are, however, hopeful factors. German competition is ceasing. Indeed, Germany is now a buyer, for costs there are now rushing up, and German prices are now stated to be higher than those of France and Britain. The trouble is, unfortunately, that the world demand for steel is restricted owing to universal impoverishment and the difficulty of arranging credits. But if this difficulty can be overcome and peace established in the shipyards there are hopes that the new wage cuts will enable the shipbuilding industry to raise its head once more, and that is the first essential to activity at the steel works. Prices are all maintained at recent levels, and there is less cutting for foreign orders, although exports contracts are still bid for at less than the fixed home quotations.

The Coal Trade.

The northern coal trade retains all its recent strength so far as anything relating to shipment up to the end of this month is concerned, but further ahead there is not quite the same assurance. The output is very satisfactory and tending to improve, and is quickly cleared. There are, however, several disturbing factors which tend to confuse the forward position. There is the home industrial trouble, and though the engineering position renders the position of the coal industry one of anxiety, its ultimate effect on the local coal trade cannot be accurately gauged. The deterioration of the foreign exchanges also reflects on the export trade, while there are reports of the success of American competitors in the Mediterranean countries, especially in Italy. Under the circumstances considerable difference of opinion exists as to the probable trend of values from April and onwards. Many merchants anticipate some recession in values, while, on the other hand, the fitters take a most optimistic view of the position and predict a firm market for some months ahead. Still, there is certainly not the same confidence in regard to the future as previously. Many of the large exporters have considerable holdings of all classes of coal, and these will have to be disposed of, so that should the demand from abroad ease off a reaction is possible. At the moment the demand and inquiry from overseas is very heavy, and the position all round is quite firm and stable for at least a month ahead. All classes of Northumberland steams are a strong market and supplies are scarce, any sort being disposable at top prices. Gas coals are in strong favour, and any of the primes and specials are difficult to obtain, while seconds are exceedingly steady. The market for gas coke continues very firm, but foundry and furnace coke is not so rigid as it was. There are supplies to be had at prices a little cheaper than recently.

SCOTLAND.

(From our own Correspondent.)

The Lock-out.

WITH the exception of Messrs. Harland and Wolff, who are not members of the Engineering Employers' Federation, all the important engineering firms in the Clyde area have closed their establishments to members of the A.E.U. In this district from 40,000 to 50,000 men are affected. Thus again, as has already happened frequently, since the end of the war, just when there seemed reason to hope for a turning towards better times, a trades dispute has been opened and a disorganisation of business threatened. A notice calling upon "active rebel elements" to attend a meeting in order to consider "rebel activity in relation to the projected lock-outs" was posted in a number of workshops. A meeting was held on Saturday night last under the joint offices of the Engineering and Shipbuilding Section of the National Workers' Committee, the Glasgow Vigilance Committee of the A.E.U., and the West of Scotland Council of the Red Trade Union International. This movement, which was attended by about one hundred delegates, was promoted by certain extremist sections, and differs from former movements in that the unofficial element is to co-operate with the official representatives of the A.E.U. Eight divisional committees were appointed to act in the districts into which the A.E.U. has divided Glasgow for lock-out organisation. These will be subject to a central committee. A "lock-out bulletin" is to be published daily.

Pig Iron.

Scotch pig iron makers are experiencing difficulty in disposing of their outputs, even though these are very restricted. There has been a little more inquiry of late on export account, but firm orders are not increasing. Prices are being cut in order to keep down stocks, and foundry qualities show a fairly steady drop. Hematite, however, remains comparatively firm. The present trade unrest is not calculated to increase the demand.

Finished Steel and Iron.

Steel prices are still inclined to firmness, and it remains to be seen if makers will maintain the present level of quotations in view of the scarcity of orders. Apart from an occasional flutter there has been little or nothing doing for a long period and great difficulty is experienced in keeping even a small number of mills in action. Steel plates are far from busy, and sectional material is more or less neglected. Black and galvanised sheets have had a fair amount of export work recently, but the demand has dropped somewhat. The mills, however, have still a fair amount of orders on hand, especially in the lighter gauges. Steel and iron tubes are very quiet at present. The various branches of the finished iron trade are in a similar position.

Coal.

The output from the collieries has been steady during the past week. Business has not altered much in character. Home sales are disappointing, round coal especially being far from busy. In the West of Scotland splints and best ells have an occasional order, but other descriptions are not doing much. Smalls, apart from drosses, account for the bulk of the orders. In Fifeshire and the Lothians business is improving, and shipping orders are increasing. Given better weather conditions and a bigger supply of steamers, the outlook is much brighter. Aggregate shipments for the past week amounted to 247,936 tons against 251,616 tons in the preceding week and 289,128 tons in the same week in 1913. Prices generally have been inclined to ease, with the exception of the quotations for splints and washed fuels.

Miners' Wages.

In a statement issued to the shareholders, Mr. Charles Carlow, chairman of the Fife Coal Company, Limited, referred to the statements made recently in the House of Commons by Messrs. Adamson, Graham and Robertson in respect to miners' wages. Mr. Carlow says it is evident that these gentlemen had placed a distorted view of the situation before the House. Mr. Adamson, while instancing the paying of a 10 per cent. dividend, free of income tax, by the Fife Coal Company, omitted to call attention to the fact that there were good and bad concerns throughout the country. Ascertainment showed that the men were getting the total proceeds of the industry, and the accountants had the books of the companies open to them in every respect. There was little doubt that the districts interested in export were suffering severely. The export coal trade was completely destroyed for want of coal during the control period, and as the districts concerned had to regain business or not work at all it was evident that prices had to be reduced in order to re-establish relations with pre-war markets. Mr. Carlow instanced the statement by Mr. Finlay Gibson "that the owners in Wales had sacrificed about £850,000 during the past three months in working the collieries."

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE is no outstanding feature that is fresh in the state of the South Wales steam coal market, although there is this satisfactory point, that the conditions are comparatively healthy, and so far as large descriptions are concerned, values are fully maintained, with the prospect of their continuing to be so for a few weeks at least, provided something unexpected does not happen. Most collieries have sold all the coal that they are prepared to sell for shipment this month, and the early part of next, and they are watching very closely developments in the labour world in America. From all accounts there is just the bare possibility that a strike may take place in the American coalfield, and if this should be the case, then, of course, the demand for coals from this country will sharply increase, and prices will undoubtedly advance. For this reason, owners are very cautious as to any further sales for April shipment, although from reports very few collieries have much coal to spare even now for the first half of next month. Recent activity in the export trade can be gauged from the fact that last week no less than close on 530,000 tons were cleared from this district, which compares with about 600,000 tons weekly before the war. Furthermore, it is some indication of the shipments being made and to be made when it is stated that last week the amount of tonnage chartered on the open market aggregated nearly 400,000 tons, this being rather more than 6000 tons greater than in the preceding week. The demand for tonnage is still good for the Mediterranean, but the inquiry for the Plate and for the near French ports is on the quiet side. The fact is that owing to the recent rise in prices, French consumers are disposed to hold off, their belief evidently being that prices are not likely to be maintained for long, but in this respect they are likely to be wrong so far as the next few weeks are concerned, if not for a longer period. With regard to the inquiry of the Bombay and Baroda Railway of India for 170,000 tons of best steam coals for delivery over the second half of this year, it is reported that the business has been placed on the basis of about 46s. for best Admiralty large and 45s. 6d. for second Admiralty large, these prices being c.i.f. Bombay/Karachi. These figures cannot be vouched for, but if they are correct then it is evident that the firms which have taken the order have discounted both the coal and freight markets for the second half of this year. Another inquiry which has come on the market since I wrote a week ago is for about 70,000 tons of Admiralty or, alternatively, Monmouthshire large coals for India, for delivery from May to October. Firms are asked to make offers on a f.o.b. and c.i.f. basis.

Shipwrights and Engineers.

It is satisfactory to record that the shipwrights' dispute has taken a better turn than was at one time feared, inasmuch as the men have resumed work. The men had stopped at Swansea, Barry and Penarth, and to some extent at Cardiff and Newport, but the Employers' Association made it known that unless the members of the Ship Constructors' and Shipwrights' Association restarted work immediately, the Bristol Channel Engineers and Ship Repairers Employers' Association proposed to decline to employ any of them. No doubt this intimation had some effect, as members of the men's executive had an interview with the President of the employers' organisation on the subject of the reopening of negotiations. This resulted in mass meetings of the men being held, and they returned to work on Tuesday on the conditions offered them a week ago, these being that a reduction of 12½ per cent. must become operative in respect to the piece rates as well as in the day rates, to apply from the 6th inst. So far as the engineers' trouble is concerned, this district is not appreciably affected. In the case of the dry dock and ship-repairing industry, the engineers are not affiliated to the Amalgamated Engineering Union. Engineers and fitters at the collieries may be affected, but colliery working will not be interfered with unless the stoppage is of long duration.

Swansea's Facilities.

Mr. Roger Beck, who on Monday last was re-elected chairman of the Swansea Harbour Trust, made an interesting statement, and said that they had passed through the greater part of their trials. The developments of the Trust were still progressing. The great asset they had always desired to possess above anything was a dry dock. In the King's Dock they had the largest water area of any dock in the country, but as a Trust they had never had a really up-to-date dry dock. Now he was pleased to say that it was an assured fact that within a few days tenders would be in for the contract, and an immediate start would be made. It would be extremely valuable to the Trust and of immense value in providing work for the unemployed.

Current Business.

All things considered, the demand for steam coals is well maintained, and prices for large qualities are fully upheld on the basis of 26s. 6d. for best Admiralties and 27s. for second qualities. Monmouthshire descriptions also keep a steady tone, but, of course, here and there some slight irregularity prevails owing to the difficulty of getting coals shipped quickly in order to provide empty wagons, but there are few exporters who have not already made arrangements for their requirements, and so are unable to take advantage of any temporary weakness which occurs in the market. On paper, collieries are well sold for the whole of this month and next, but the improvement in the export trade and the increased production of large coals means that smalls are rather more plentiful, and these grades are weaker, the price of best steam smalls now being 19s. to 19s. 6d. Highly bituminous qualities and sized coals are still scarce. There is no change in the anthracite section, and this market is no weaker so far as large coals are concerned, while the tendency of nuts, cobbles and beans, as well as culm and duff, is rather towards improvement. Hopes are entertained that before very long something will be done with regard to the question of altered working conditions at the docks, in order to do away with the delays and facilitate the shipment of coals. The national conference of representatives of the employers and others interested in the docks and workmen's representatives have agreed that joint meetings shall be held in the various areas with a view to the ascertainment of the facts and to recommend such rearrangements of conditions of working as may seem requisite. These sectional meetings are to report back not later than the 31st inst., and a further national conference will be held on April 2nd.

Latest News from the Provinces.

NORTH OF ENGLAND.

Another Furnace to be Restarted.

A SECOND furnace is to be re-started at the Seaton Carew Ironworks, West Hartlepool, this week-end.

Longer Working Day Wanted.

A proposal to lengthen the working day for men at the Cleveland ironstone mines has been made by the employers, and will be discussed at a joint meeting to be held early in April.

WALES AND ADJOINING COUNTIES.

Coalowners' Association.

Sir Leonard Llewelyn, K.B.E., has been elected chairman of the South Wales Coalowners' Association for the ensuing year, and Mr. Charles E. Cleeves vice-chairman. The output of coal for the three districts last year is given as follows:—Cardiff district, 18,255,651 tons; Newport district, 6,881,580 tons; and Swansea district, 3,344,456 tons. The total decrease compared with 1920 was 13,133,287 tons, or 31.8 per cent. The Association now embraces collieries which represent 93 per cent. of the output of the coalfields. Six new members have been admitted since the last annual meeting.

Swansea Metal Exchange.

Business in the tin-plate trade is still very restricted, but the tone of the market is rather better at 18s. 9d. to 19s. basis I.C. f.o.b. for prompt shipment. The industry has not so far been affected by the chemical workers' strike or the lock-out of engineers.

CATALOGUES.

HIGGS BROTHERS, Sand Pits, Birmingham.—A copy of Messrs. Higgs' monthly magazine.

JOHNSON AND PHILLIPS, Limited, Charlton, London, S.E. 7.—A copy of "Transformer Abstracts," by the designer.

ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT, Berlin.—Illustrated book which has for its title "Electricity in Steel Works."

HERBERT MORRIS, Limited, Loughborough.—Book No. 97 on Morris hand cranes. Illustrations of many types with prices are given.

MEDWAY'S SAFETY LIFT COMPANY, Limited, 1 and 2, Bucklersbury, E.C. 4.—Pamphlet in connection with Messrs. Medway's "Britain's Best Electric Lifts."

BROWN AND TAWSE, Limited, 3, London Wall Buildings, E.C. 2.—In a new catalogue just issued the B. and T. system of reinforcement is discussed and illustrated.

THE HOFFMANN MANUFACTURING COMPANY, Limited, Chelmsford.—Booklet on "Reducing Colliery Working Costs with Hoffmann Bearings." The booklet is illustrated.

WILLIAM ASQUITH (1920), Limited, Halifax.—Illustrated leaflet, the subject being "Portable Universal Radial Drilling Machine." Views of machines at work are embodied.

AKROYD-STUARTS, Limited, Perth, West Australia.—Illustrated pamphlet on the Akroyd producer gas plants for wood, coke, or charcoal fuels. Drawings of different plants are given.

INTERNATIONAL TIME RECORDING COMPANY, Limited, 57, City-road, E.C. 1.—Catalogue entitled "Guarding the Minute." Examples are reproduced of the recording apparatus and its work.

OLDHAM AND SON, Limited, Denton, near Manchester.—Catalogue describing and illustrating special process accumulators. The many price lists have been collected and bound into an attractive cover.

WRIGHT MOTORS, Limited, Century Works, Halifax.—Illustrated price list of single, two and three-phase induction motors, pipe ventilated and totally enclosed induction motors, and crane rated motors.

BENN BROTHERS, Limited, 8, Bouverie-street, E.C. 4.—We have received an illustrated catalogue of technical, art and general books which will be issued by Messrs. Benn Bros. during the coming spring.

W. RICHARDS AND SONS, Limited, Britannia Foundry, Middlesbrough-on-Tees.—The sixth edition of pile shoe catalogue is to hand. Pile shoes of every style are described and coloured reproductions have been included.

THE PORT OF SWANSEA: TIDES, RATES AND DOCK FACILITIES, 1922. Published by the Swansea Harbour Trust.—This booklet is intended to supply information to all persons who are likely to make use of the port. A great deal of detail has been collected and arranged by Mr. H. N. Appleby. A map of the docks is included.

F. A. WILKINSON AND PARTNERS, Limited, Hatfield, Herts.—A copy of the second edition of a pamphlet on wind power for the generation of electrical energy, by means of improved automatic high-speed wind dynamos having rotating fields and armatures revolving in opposite directions, by which a greatly increased electrical output is obtained.

THOMAS BROADBENT AND SONS, Limited, Central Ironworks, Huddersfield.—A copy of the new electric capstan catalogue. Messrs. Broadbent have constructed a standard type of capstan which embodies many special and distinctive features. What these features are is fully set forth in the catalogue and a large number of illustrations have been embodied.

VICTORY PIPE JOINT COMPANY, Limited, 28, Victoria-street, S.W. 1.—Revised price list of "Victaulic" joints, which have been standardised by a large number of British tube manufacturers.

JOHN M. HENDERSON AND CO., King's Works, Aberdeen.—Catalogue on electric overhead travelling cranes. Besides being fully illustrated, the descriptive matter is reproduced in four languages. The number of the book is List 40/2 E.

HENRY WELLS OIL COMPANY, 11, Haymarket, S.W. 1.—To all interested in the lubrication of plant and machinery the little booklet issued by the above-named company will impart much useful information. It is entitled "Germ Process Motoils."

ENGINEERING AND LIGHTING EQUIPMENT COMPANY, Limited, Sphere Works, St. Albans, Herts.—Illustrated price list of ship, dock, mill and colliery fittings. The whole of these fittings are standardised and interchangeable, and most of them have been devised to take the anti-vibrator device.

O. N. BECK, 11, Queen Victoria-street, E.C. 4.—Leaflet describing and illustrating the "Artus" adjustable multiple-spindle drill head. This appliance is for vertical drilling machines of all types and is fitted with two to six spindles. Pictures are given in the leaflet showing various drill spindle positions with arrows indicating the possibilities of adjustment.

GENERAL ELECTRIC COMPANY, Limited, Magnet House, Kingsway, W.C. 2.—Leaflet No. OS 2569, descriptive of the Osglim lamp, which is the most recent development in low candle-power illumination. Two forms of lamps are made—the "Lighting" and the "Letter." The lamps may be put to many uses. Also a leaflet ND which deals with the "Kingsway" wiring system.

FROM Head, Wrightson and Co., Limited, of Stockton-on-Tees a leather case containing a number of new booklets dealing with mining machinery of all kinds, together with some of the makers' more familiar catalogues, such as those concerned with the Marcus conveyor, the Note Nos coal washer, pit headgears, &c. Among the new booklets, one of special interest is that dealing with the Skinner multiple-hearth roasting furnace.

W. BERNET AND CO., Limited, iron and steel merchants, Amsterdam.—A very well-produced and instructive catalogue has been received from the above firm. Qualities, sizes, and sections of iron and steel which the firm keeps in stock are tabulated. An index has been included and coloured sections have been introduced. In addition, different tables have been embodied and the book also contains a private telegraphic code. The sole agent in the United Kingdom is H. Edwards, Limited, 66, Victoria-street, S.W. 1, and copies of this catalogue may be obtained on request.

SIMPLEX CONDUITS, Limited, Garrison-lane, Birmingham.—List No. 915 is issued as a supplement to the general catalogue of conduit and conduit fittings. Illustrations have been purposely omitted, the list being intended only to schedule the current prices of this section, as it is proposed to issue a new edition of the catalogue shortly. Particular attention is drawn to the recent introduction of certain distinctive features of the conduit, such as the Simplex transfer, which is now being issued, and also the cardboard caps which are supplied for the protection of the threads.

TANNER'S TRADE CIRCULAR. Issued by Messrs. R. T. Tanner and Co., Limited, to printers and stationers.—This circular appears again after a rest of several years. Amongst its pages we see a note on the employment of bamboo as the staple material of some papermaking mills in India. Whilst there are difficulties in the way, there is no reason why the idea should not be considered for its use in our paper mills at home. A note is given to the effect that a great demand exists for a transparent grainless paper of good tensile strength at the present time.

BRETT'S PATENT LIFTER COMPANY, Limited, Foleshill Works, Coventry.—General catalogue of drop forging equipments. A comprehensive and exceedingly well got up catalogue dealing with all phases of drop forging work. All types of lifters are represented: steam and compressed air driven, friction or electrically driven drop hammers, and in each case there are suggested arrangements of plants. Particulars are also given of power consumption, as well as views of typical installations. Information is also given concerning furnaces of various types, special types of hammers, and clipping presses. The volume also includes some notes on heat treatment and other matters.

ATELIERS DE CONSTRUCTION ELECTRIQUES DE CHARLEROI, 58, Victoria-street, S.W. 1.—General booklet deals with the works of the company and its manufactures. The works were occupied by the Germans during five years of the war. Since the Armistice the firm has re-established itself so well that at the present time over 5000 people are employed. The catalogue is divided into twelve sections, fully illustrated, which deal respectively with dynamos and motors, static transformers, converting machinery, including La Cour motor converters, rotary converters and motor generators, power stations, traction plant and equipment, electric colliery winding engines, travelling cranes, lifting and transporting machinery, dock cranes, centrifugal pumps, switchgear, wires and cables, &c., and electrical signalling apparatus.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are asked to state that Mr. C. L. Dalton, for many years representative of the *Electrician* in Birmingham, has joined the staff of Maurice G. Parker.

WE are informed that Mr. J. W. P. Laird has been appointed assistant to the Managing Director of Messrs. Cammell Laird's Shipbuilding and Engineering Works, at Birkenhead.

POOLEY AND AUSTIN, of 34, Broadway, Westminster, London, S.W. 1, inform us that in connection with the liquidation of the Wilson-Wolf Engineering Company, Limited, they have, under the reconstruction scheme, been re-appointed the sole London agents for the new firm.

THE L.C.C. has given the contract for the supply of foundry plant to its Central Car Repair Depôt to Alldays and Onions, Limited, of Great Western Works, Birmingham. This firm is among the oldest engineering concerns in the kingdom, having been established in 1650.

MR. CHARLES W. RICHARDSON, of Reliance Works, Lower Carrs, Stockport, the inventor and original maker of the R.P. pump lubricator, informs us that his late company, A. W. Richardson and Sons, Limited, of Ashton-under-Lyne, having gone into voluntary liquidation and the business closed down, he has completed arrangements to manufacture and supply the lubricators himself.

WE understand that a permanent wireless aerial for reception purposes has been installed on the building of the Institution of Electrical Engineers on the Victoria Embankment in London. The details are as follows:—Span between strain insulators, 113ft.; down-lead from aerial to leading-in insulator, outside, 63ft.; down-lead from leading-in insulator to floor of lecture theatre, 44ft.; total length of down-lead, 107ft. The effective length of the aerial, down-lead plus half span, is therefore 163.5ft. The natural wave length is approximately 200 m.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	28/-
(1) Spanish	28/-
1) N. African	28/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	27/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) **Scotland—**		
Hematite	5 7 6	—
No. 1 Foundry	5 2 6	—
No. 3 ,,	4 17 6	—
N.E. Coast—		
Hematite Mixed Nos.	5 0 0	5 0 0
No. 1	5 1 0	5 1 0
Cleveland—		
No. 1	4 15 0	4 15 0
Silicious Iron	4 15 0	4 15 0
No. 3 G.M.B.	4 10 0	4 10 0
No. 4 Foundry	4 7 6	4 7 6
No. 4 Forge	4 2 6	4 2 6
Mottled	3 15 0	3 15 0
White	3 15 0	3 15 0
Midlands.		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
Part Mine Forge	*None offering.*	
North Staffs. No. 3 Foundry	4 5 0 to 4 10 0	
(3) Northampton—		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	4 0 0	—
,, Forge	3 10 0 to 3 12 6	
(3) Derbyshire—		
No. 3 Foundry	4 2 6 to 4 5 0	
Forge	3 15 0	—
(3) Lincolnshire—		
Basic	4 0 0 to 4 5 0	
Foundry	4 5 0 to 4 10 0	
Forge	4 2 6 to 4 5 0	
(4) N.W. Coast—		
N. Lancs. and Cumb.		
Hematite Mixed Nos.	5 10 0 to 5 15 0	

MANUFACTURED IRON.

	Home. £ s. d.	Export £ s. d.
Scotland—		
Crown Bars	11 10 0	—
Best ,,	12 0 0	—
N.E. Coast—		
Common Bars	12 0 0	—
Tees	14 10 0	—
Lancs.—		
Crown Bars	12 0 0	—
Hoops	14 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	13 0 0	—
Hoops	14 0 0	—
Midlands—		
Marked Bars (Staffs.)	14 10 0	—
Crown Bars	11 10 0 to 12 0 0	
Nut and Bolt Bars	10 15 0	—
Gas Tube Strip	12 10 0	—
Hoops (*Nom.*)	14 0 0 to 15 0 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) **Scotland—**		
Boiler Plates	14 0 0	—
Ship Plates ⅜in. and up	10 10 0	—
Sections	10 0 0	—
Steel Sheets ¼in. to ⅜in.	11 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	£16 10 0 to 17 0 0

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 10 0	—
Joists	10 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	14 10 0	—
Hard Billets	9 5 0	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Ship Plates	10 10 0	—
Boiler ,,	14 10 0	—
Manchester (*Prices irregular and uncertain, unchanged*)—		
Bars (Round)	10 0 0 to 12 0 0	
,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	—
Sheffield—		
Siemens Acid Billets	10 0 0 to 11 0 0	
Bessemer Billets	12 10 0	—
Hard Basic	9 5 0	—
Soft ,,	7 10 0	—
Hoops	12 5 0	—
Soft Wire Rods	11 0 0	—
Midlands—		
Small Rolled Bars	9 10 0	—
Bessemer Billets	7 10 0 to 8 0 0	
Hoops	12 0 0	—
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (24 W.G.)	12 10 0 to 13 10 0	
Galv. Sheets (f.o.b. L'pool)	16 0 0 to 16 5 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18 9 to 19/-
Block Tin (cash)	142 15 0
,, (three months)	144 10 0
Copper (cash)	60 12 6
,, (three months)	61 12 6
Spanish Lead (cash)	21 0 0
,, (three months)	20 17 6
Spelter (cash)	25 12 6
,, (three months)	25 12 6
Manchester—	
Copper, Best Selected Ingots	66 0 0
,, Electrolytic	68 0 0
,, Strong Sheets	90 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	22 15 0
,, Foreign	21 0 0

FERRO ALLOYS.

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/6 per lb.	
Ferro Tungsten	1/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£27	10/-
,, 6 p.c. to 8 p.c. ,,	£26 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£25 10 0	8/-
,, Specially Refined		
Max. 2 p.c. carbon	£70	26/-
,, 1 p.c. ,,	£68	3½/-
,, 0·75 p.c. carbon	£103	37/-
,, carbon free	2/- per lb.	
Metallic Chromium	5/3 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£25 10 0 scale 6/- per unit	
,, Vanadium	20/- per lb.	
,, Molybdenum	7/- per lb.	
,, Titanium (carbon free)	1/3 per lb.	
Nickel (per ton)	£180	
Cobalt	14/- per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

	Export.
Scotland.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	21/6
,, ,, Ell	22/
,, ,, Splint	23/- to 26/-
,, ,, Trebles	24/-
,, ,, Doubles	22/-
,, ,, Singles	19/-
Ayrshire—	
(f.o.b. Ports)—Steam	22/-
,, ,, Splint	23/-
,, ,, Trebles	24/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	20/- to 23/-
Screened Navigation	28/-
Trebles	24/6
Doubles	22/-
Singles	19/-
Lothians—	
(f.o.b. Leith)—Best Steam	22/-
Secondary Steam	21/6
Trebles	24/6
Doubles	22/6
Singles	19/-
England.	
(8) **N.W. Coast—**	
Steams	35/-
Household	40/- to 55/-
Coke	24/-
Northumberland—	
Best Steams	25/- to 26/-
Second Steams	23/- to 23/6
Steam Smalls	14/- to 15/-
Unscreened	21/6
Household	25/- to 30/-
Durham—	
Best Gas	23/- to 23/6
Second	21/- to 22/-
Household	25/- to 30/-
Foundry Coke	38/- to 40/-
Sheffield—	**Inland.**
S. Yorks. Best Steam Hards	22/- to 23/- —
Derbyshire Hards	21/- to 22/- —
Seconds	20/- to 21/- —
Cobbles	19/- to 20 - —
Nuts	17/- to 18/- —
Washed Smalls	11/- to 12 - —
Best Hard Slacks	12/- to 13/- —
Seconds ,,	10/- to 11/- —
Soft Nutty ,,	9/- to 10/- —
Pea ,,	7/- to 8/- —
Small ,,	4/- to 5/- —
House, Branch	37/- to 39 - —
,, Best Silkstone	34/- to 35/- —
Blast Furnace Coke (Inland and Export)	17/6 to 25/-

Cardiff— (9) **South Wales.**	
Steam Coals:	
Best Smokeless Large	27/- to 27 6
Second ,, ,,	26/6 to 27/-
Best Dry Large	26/6 to 27/-
Ordinary Dry Large	25/- to 26/-
Best Black Vein Large	26/6 to 27/-
Western Valley ,,	26/- to 26/6
Best Eastern Valley Large	26/- to 26/6
Ordinary ,, ,,	24/- to 25/-
Best Steam Smalls	19/- to 20/-
Ordinary ,,	15/- to 19/-
Washed Nuts	27/6 to 32/6
No. 3 Rhondda Large	30/- to 32/6
,, ,, Smalls	20/- to 22 -
No. 2 ,, Large	23/6 to 24/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	16/- to 18/-
Coke (export)	30/- to 35/-
Patent Fuel	26/- to 28/-
Pitwood (ex ship)	31/- to 32 -
Swansea—	
Anthracite Coals:	
Best Large	37/6 to 40/-
Seconds	30/- to 35/-
Red Vein	29/- to 30/-
Big Vein	37/6 to 40/-
Machine-made Cobbles	50/- to 55/-
Nuts	57/6 to 60/-
Beans	50/- to 55/-
Peas	20/- to 22,6
Breaker Duff	9/- to 9/6
Rubbly Culm	13/- to 14/-
Steam Coals:	
Large	21/- to 24/-
Seconds	20/- to 22.6
Smalls	13/- to 18/-
Cargo Through	18.6 to 20/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Industrial Problems.

THERE are two things that are specially occupying the attention of the engineering industries just now, one being the growing importance of providing new markets for products abroad and the other the necessity of increasing production and bringing down manufacturing costs by some modification of the eight hours' day. In a general way, the amount of work to be done in this country, as soon as there is sufficient money available, would seem to render manufacturers less dependent upon foreign business than makers elsewhere, but in view of the way in which the productive facilities have been increased, to the extent that the industrial interests have become almost as great as the agricultural, it will obviously need such an expenditure to provide the works with employment as will only be possible by a readjustment of the financial position. As this may take some years, manufacturers must look for immediate relief to foreign trade, and they are accordingly taking a more direct interest in the proposals for industrial reconstruction, which means that they will have to abandon more or less the exclusive attitude they have adopted with regard to their own market. At the same time, the necessity for increasing the working hours as a means of bringing down the cost of production is so general that various proposals are being made to give a more liberal interpretation to the Eight Hours Bill without sacrificing its principle. The Minister of Public Works has announced that the railwaymen will be required to put in eight hours' effective work each day, to the exclusion of unoccupied time, and he proposes that the operations of the Bill in the coal-mining industry should be suspended so long as the imports of foreign coal exceed a stated figure. It is argued, however, that such a reservation would deprive the colliers of the benefit of the Bill for all time. The adjustment of the eight hours' day to the changed conditions of trade and industry will evidently give rise to considerable controversy, and while the men will certainly have to work more hours there will be a good deal of trouble in overcoming the opposition of an important section, although in many branches the workers are quite prepared to put in more hours if, by so doing, they can earn more money.

Foreign Trade.

The necessity of adopting every expedient that may assist in a recovery of trade is observable in the returns of foreign trade during January, when the values showed a further decrease in imports and exports, which for some months previously had been steadily declining. It is very difficult to institute an exact comparison between the various returns published, owing to the different methods adopted for the valuation of goods, but for the first time in January the estimation of the import values was not left to the Customs appraisers, but was based upon the declarations of importers, who are now required to state the correct values, with a view to the assessment of taxes on turnover. The exports, however, continue to be subjected to Customs valuation. During the first month of the year the value of imports was given as 1487 million francs, showing a decline of 886 million francs as compared with January, 1921. The exports totalled 1638 million francs, a decrease of 252 million francs, chiefly in manufactured goods. There was a small increase in the exports of raw material, and as the imports of raw material declined at the same time by 494 million francs, it is surmised that much less is going into home consumption, with the result that there must be a falling off in the production of manufactured goods. This is confirmed by the returns giving the tonnage showing that there was a declension in the raw material imports of 714,113 tons and an increase in the exports of raw material of 403,284 tons. In both cases there was a drop in the tonnage of manufactured goods.

Saar Coke.

The dependence of French blast-furnace owners upon the Ruhr for supplies of coke is not only objectionable because it places them at the mercy of the Germans, but the quantity of combustible obtainable from that source will never be sufficient to permit of the metallurgical industry developing to its full capacity. For a long while past, therefore, the French have been experimenting with methods of treating Saar coal with a view of producing suitable coke, and so far as laboratory tests are concerned they have proved satisfactory, particularly the process of M. Charpy, who first subjects the coal to a sudden temperature of 450 deg. to 500 deg. Cent., and then slowly completes the distillation at 800 deg. to 900 deg. Cent. In view of the results obtained, special ovens are being constructed at Heinitz for the distillation of coal by this system, and it is expected that they will be in operation during the second half of the year. The Saar mines also intend to carry out experiments in existing ovens by adding to the charge of fresh coal a certain proportion of coal that has been semi-distilled in a special oven. The coke thus produced will be employed in some of the blast-furnaces at Heinitz, and others will use Ruhr coke, and the relative values of the cokes will be judged by the quality of the pig iron. If the Saar combustible gives satisfactory results, a serious obstacle to the development of the metallurgical industry will be overcome.

Bridge Disaster.

A ferro-concrete bridge in construction across the Seine at Saint-Pierre-de-Vauvray, near Louviers (Eure), collapsed during the cyclone last week, with the loss of five lives. The bridge was to have replaced one that fell nine years ago. Built in two spans, it was to have had a length of 131 m., with a 5.80 m. roadway and two pavements 1.50 m. each. A wooden structure had been erected with a cable runway across the river for placing the ferro-concrete blocks in position. During the cyclone the wooden structure gave way and fell into the river, carrying with it the partially built bridge. Nothing remained but the two metal standards which carried the runway cable.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

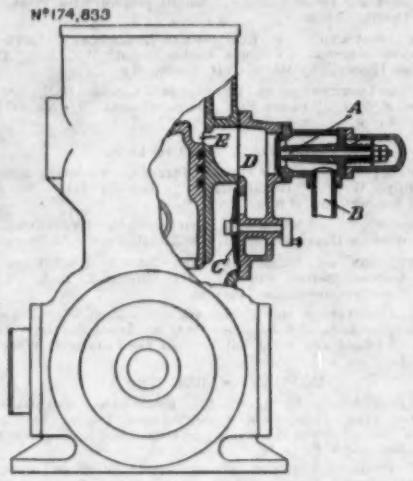
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

174,833. December 16th, 1920.—IMPROVEMENTS IN AND RELATING TO GAS ENGINES, Percival Waddams Potter, of West Park House, Yeovil, Somerset, and Potters Limited, of Nautilus Works, Yeovil, Somerset.

IN the drawing, A is the gas valve, which is controlled by a spring. The gas valve-box receives the fuel from a pipe B, whilst a rotary baffle valve C, controlled by the governor, controls the supply of air to the chamber D from the crank chamber. The moment the inlet port E is uncovered by the piston, the difference in pressure between the cylinder and the crank chamber causes a rush of air from the latter through the chamber D, and this air mixes with the gas and they both enter the engine through the port E. The gas valve opens as soon as

N°174,833



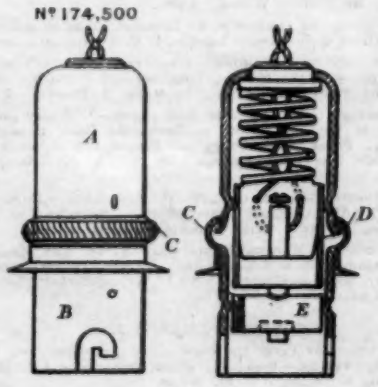
the piston has covered the port E, and as the piston continues its upward stroke air is drawn into the crank case through the air valve at the back of the crank case in the usual manner. At the same time gas is driven into the gas chamber D through the gas valve A. When the piston commences its downward stroke, the gas valve A is closed by the spring behind it, and is held closed after the port is uncovered by the piston by the pressure caused by the rush of air from the crank case. Absolute safety is claimed to be secured, as the gas is received in the special gas chamber D, and is not drawn into the crank case.—*February 6th*, 1922.

SWITCHGEAR.

174,500.—November 27th, 1920.—ELECTRIC LAMP AND SWITCH HOLDER, Alexander Pender Rutherford, of 9, Summerside-place, Leith, and Andrew Nesbit Haddow, of 3, Antigua-street, Edinburgh.

The combined switch and lamp-holder described in this specification is composed of two parts A and B, and by turning the collar C in one direction or the other, the current is switched on or off. It will be seen from the sectional view that the upper

N° 174,500



part has indentations which fit into grooves in the member D, which holds the contacts and which cannot turn. This member, it will be seen, is pressed downwards by a spring, and the contacts are therefore forced into connection with the contacts of the member E, which turns with the lower part B and forms the switch.—*February 2nd*, 1922.

TRANSFORMERS.

174,866. February 26th, 1921.—IMPROVEMENTS IN THE CONSTRUCTION OF ELECTRIC TRANSFORMERS, William Parry, of 2, Queensland-avenue, Earlsdon, Coventry.

Experience has shown that with some types of transformers it is necessary to employ, in connection with the devices for clamping the coils, arrangements for taking up any slack which may result from the shrinking of the coils. In the drawing the main spring A is coiled around the clamping member, which is a screw-threaded plunger B, which carries a nut C attached to the top end of an auxiliary cylindrical spiral spring D arranged to exert a torsional effort upon the nut C, tending to rotate the latter in such a direction as to tighten it up against the under side of a flange. The bottom end of the spring D is anchored to a lower flange. The plunger B is provided with a collar E, which fits into a cup or channel, which communicates the pressure exerted by the spring A to the windings of the transformer. Any shrinkage taking place in the coils will be compensated by a downward movement of the plunger B under the pressure of the main spring A. This will relieve the pressure between the channel upper flange and the nut C, thus reducing

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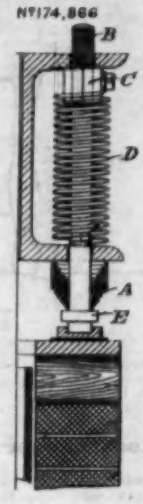

the friction between these parts and permitting the torsional effort of the spring D to rotate the nut C until the original pressure between the channel and nut is reproduced, and the spring A is relieved from the necessity of supporting the disruptive pressure put upon the coils due to short circuits.—*February 9th*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

174,765. November 6th, 1920.—IMPROVEMENTS IN MACHINES FOR BENDING THE PLATES FOR LAMINATED SPRINGS, Crocker Brothers, Limited, of Fitzalan Works, Effingham-road, Sheffield, and Francis Moss Moody, of 275, Granville-road, Sheffield.

When bending a plate with the machine described in this specification, the top part A descends and causes the chain B to press on the heated plate, and both the chain and plate adapt themselves to the contour of a series of segmental blocks

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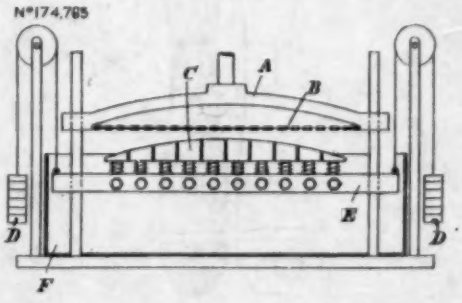

C. The pressure also overcomes the upward pressure exerted by the weights D, and forces the whole of the lower part E into an oil tank F, where the spring plate is quenched.—*February 6th*, 1922.

MINES AND METALS.

174,522. January 12th, 1921.—ROCK DRILLS, *E. C. E. Marks*, 57, 58, *Lincoln's Inn-fields, London, W.C. 2.*

The inventor argues that it is dangerous to use an air feed for stoping, as there is no positive control in the event of the

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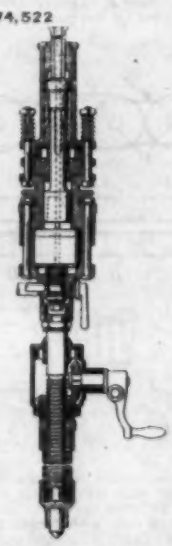

drill steel breaking. He thus proposes to use a screw feed, as shown, operated by a handle and mitre gearing.—*February 2nd*, 1922.

MOTOR CARS AND ROAD TRAFFIC.

174,525. January 20th, 1921.—IMPROVEMENTS RELATING TO ELECTRIC LAMPS FOR VEHICLES, Henry Lucas and William Henry Egginton, both of Joseph Lucas, Limited, of Great King-street, Birmingham.

The object of this invention is to avoid vibration being transmitted to the electric lamps of a motor vehicle. Instead of the

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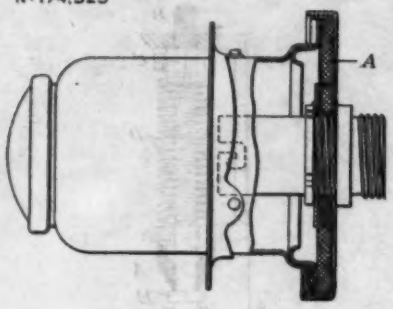


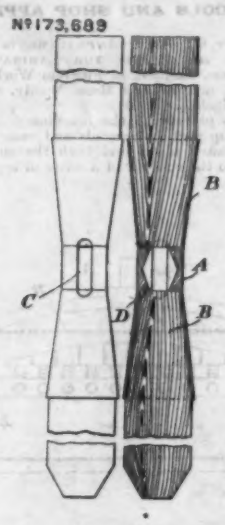
lamp being rigidly fixed in the usual manner, the holder is attached to a flexible diaphragm A, which is composed of rubber.—*February 2nd*, 1922.

MISCELLANEOUS.

173,689. December 18th, 1920.—IMPROVEMENTS IN OR RELATING TO PIT PROPS AND THE LIKE, Henry John Thackeray, of 80, Charlesworth-street, Carr Vale, Bolsover, near Chesterfield, and Luther Henton, of Creswell Colliery, near Mansfield.

The object of this invention is to provide an improved connector device to enable partly broken props to be utilised. A central cylindrical sleeve A has at its extremities outward projecting bell-mouthed socket portions B into which tapered ends of the broken prop fit, whilst the sleeve A has longitudinal

Nº 173,689

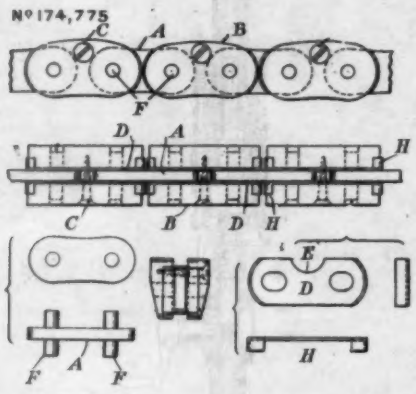


slots C formed in the opposite walls with internally cast shoulders D, which obviously serve to limit the inward movement of the two parts of the prop. The two parts of the prop can be withdrawn by driving a metal wedge into the slot C.—*January 12th*, 1922.

174,775. November 11th, 1920.—IMPROVEMENTS IN OR RELATING TO LINK BELTING, Oscar Lyon Whittle, of Victoria House, Wildspool, Lancaster.

The drawing shows part of a belt constructed in accordance with this invention. Metal links are shown at A and links composed of leather or similar material at B. Screws C are inserted in the leather links to hold them together. Each of the leather links B is provided with a metal sheath D, with straight sides, and one side has a recess E to provide clearance for the screw. Holes are also provided for the pins F of the metal links, which

Nº 174,775



also pass through the leather links, and the holes are elongated so that they will not come into contact with the pins F. Each sheath is arranged to cover the inner face of each leather link, and is provided at its ends with flanges H, which embrace the ends of the leather links. When the parts are assembled, the ends of the links B bear against the flanges H of the metal sheath D, and it is therefore impossible for the leather links to stretch, but at the same time a certain amount of elasticity is permitted by the elongated holes.—*February 9th*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

THE INSTITUTION OF MECHANICAL ENGINEERS.—The Institution, Storey's-gate, St. James's Park, S.W. General meeting. "British and American Locomotive Design and Practice," by Mr. P. C. Dewhurst, of Kingston, Jamaica. 6 p.m.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—Queens' Hotel, Leicester-square, W.C. 2. Smoking concert. 8 p.m.

INSTITUTE OF TRANSPORT.—Royal Society of Arts, John-street, Adelphi, W.C. Lecture. "The Operation of an Omnibus Company, with reference to Capacity and Cost under Given Conditions," by Mr. F. Pick. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Pigments and Mediums of the Old Masters," by Professor A. P. Laurie. 9 p.m.

THE INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Mappin Hall of the University of Sheffield, St. George's-square. Paper on "Some Nickel Alloys," by Mr. W. R. Barclay. 7.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE.—24, Royal Technical College, George-street, Glasgow. "The Work of Sorby and the Development of Metallography," by Professor C. H. Desch. 7 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Victoria Embankment, W.C. 2. "The Electron Theory," by Mr. C. C. H. Wade. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, Westminster, S.W. 1. "Power Factor Improvement," by Mr. G. H. Ayres. 8 p.m.

SATURDAY, MARCH 18TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Radioactivity." Lecture III. By Sir Ernest Rutherford. 3 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Western District meeting. Guildhall, Exeter. 2.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting. The Guildhall, York. 2.30 p.m. Executive meeting, 1.30 p.m.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, Fleet-street, E.C. 4. Discussion on "The Merits of Diesel and other Oil Engines for Industrial Work." 7.30 p.m.

MONDAY, MARCH 20TH.

THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—The Institution, Storey's-gate. Paper, "Hydro-electric Course at the University of Grenoble," by Captain H. Whittaker, late R.E. (A.M.). 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—At the Royal Technical College, Glasgow. Paper, "The Design and Functioning of Laminated Automobile Suspension Springs," by Mr. A. A. Remington. 7.30 p.m.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. "The Heat Extraction Engine," by Professor G. F. Charnock. 7.30 p.m.

THE INSTITUTION OF MECHANICAL ENGINEERS.—At the City of Bradford Technical College. Joint meeting with the Bradford Engineering Society. "The Heat Extraction Engine," by Professor G. F. Charnock. 7.30 p.m.

THE INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Hotel Metropole, Leeds. "Modern Methods of Water Purification," by Mr. N. K. Holmes. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. Cantor Lecture: "The Constituents of Essential Oils," by Mr. L. Guy Radcliffe, F.I.C. 8 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The University, Liverpool. "The Interconnection of Alternating-current Power Stations," by Mr. L. J. Romero and Mr. J. B. Palmer. 7 p.m.

TUESDAY, MARCH 21ST.

THE INSTITUTION OF CIVIL ENGINEERS.—Paper, "All-electric Automatic Power Signalling on the Metropolitan Railway," by Mr. William Willox. 6 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Connaught Rooms, Great Queen-street, London, W.C. 2. Annual dinner.

INSTITUTION OF AUTOMOBILE ENGINEERS: LOUGHBOROUGH GRADUATES.—At the College, Loughborough. Paper, "Electric Lighting and Starting Sets," by Mr. G. A. Pearson. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Ordinary general meeting of the Institution at Broadgate Café, Broadgate, Coventry. Paper, "The Design and Functioning of Laminated Automobile Suspension Springs," by Mr. A. A. Remington. 7.45 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Engineers' Club, 17, Albert-square, Manchester. "Specifications and Estimates," by Mr. J. Frith. Informal meeting. 7 p.m.

INSTITUTE OF MARINE ENGINEERS.—85/88, The Minories, E. 1. "Animal Life at Sea, including all Living Things Generally Seen, with Notes on Flight," by Sir D. Wilson-Barker. Lantern views. Ladies' night. 6.30 p.m.

WEDNESDAY, MARCH 22ND.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—Paper on "Earth Pressures and Retaining Walls," by Mr. W. B. Wignall. 6 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the Birmingham Graduates to the Bearing Works of Rudge-Whitworth, Limited, Reddings-lane, Sparkhill, Birmingham. Graduates will meet outside the works at 2.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—At the Assembly Room, Education Offices, Salford, Manchester. Paper, "Torque Diagrams for Internal Combustion Engines," by Mr. A. T. J. Kersey. 7.30 p.m.

THE INSTITUTE OF COST AND WORKS ACCOUNTANTS, Limited.—At the Hall of the Institute of Chartered Patent Agents, Staple Inn Buildings, Holborn, W.C. "Costing at Longbridge Works," by Sir Herbert Austin, K.B.E. 7 p.m

INDUSTRIAL LEAGUE AND COUNCIL.—Caxton Hall, Westminster, S.W. 1. "Some Common Fallacies in Trade and Industry," by Mr. G. N. Barnes. 7.30 p.m.

THURSDAY, MARCH 23RD.

CHADWICK PUBLIC LECTURES.—Gallery of Royal Institute of British Architects, 9, Conduit-street, W. 1. Two lectures on "Water." Lecture I.: "Its Storage and Filtration," by Mr. H. E. Stilgoe. 8 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Special general meeting of corporate members and associates to consider certain resolutions. 5.45 p.m.

NORTHAMPTON ENGINEERING COLLEGE ENGINEERING SOCIETY.—"Electric Locomotives," by Mr. R. E. Dickinson (L. and N.W. Railway). 5.30 p.m.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—Royal Technical College, Glasgow. "Phenomena Associated with the Flow of Steam Through Nozzles," by Dr. Mellanby. 7 p.m.

THE CONCRETE INSTITUTE.—Denison House, 296, Vauxhall Bridge-road, S.W. 1. "Floating Docks," by Mr. S. F. Staples. 7.30 p.m.

THE INSTITUTION OF MECHANICAL ENGINEERS.—North-Western Section. Memorial Hall, Albert-square, Manchester. "British and American Locomotive Design and Practice," by Mr. P. C. Dewhurst. 7 p.m.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—Caxton Hall, Westminster, S.W. 1. "Modern Production and Costing Methods as Applied to Locomotive Engineers," by Mr. A. E. Howell. 7.15 p.m. Annual general meeting at 7 p.m.

NEWCASTLE-ON-TYNE Y.M.C.A.—Junior Chamber of Commerce, Room No. 3, Y.M.C.A. Buildings, Blackett-street, Newcastle-on-Tyne. "The Reclamation and Utilisation of Waste Products," by Mr. G. H. Ayres. 7.30 p.m.

FRIDAY, MARCH 24TH.

INSTITUTION OF PRODUCTION ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, S.W. Paper, "Inspection Methods," by Mr. E. Fairbrother. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, S.W. 1. Question and General Discussion Meeting. 8 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Irish District meeting. Library of the Institution of Civil Engineers of Ireland, 35, Dawson-street, Dublin. 2.30 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS.—Memorial Hall, Albert-square, Manchester. Annual general meeting. Election of members and officers. "Commercial Motors," by Mr. J. G. P. Thomas, of Leyland. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. Informal meeting. "Cheap Transport: Heat and Power, with Special Reference to the D. J. Smith Gas Producer," introduced by Captain P. P. Stanford. 7 p.m.

ROYAL SOCIETY OF ARTS: INDIAN SECTION.—John-street, Adelphi, W.C. 2. "The Indigo Situation in India," by Professor Henry E. Armstrong. 4.30 p.m.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—In the Lecture Theatre of the Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. "On a Subject Connected with Reduction Gearing," by Dr. J. H. Smith. 6.30 p.m.

SATURDAY, MARCH 25TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS: NORTH-WESTERN DISTRICT.—Council Chamber, Town Hall, Blackpool. 11 a.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Visit of the London Graduates to the works of the Skefko Ball Bearing Company, Limited, Luton. Graduates will catch the 1.40 p.m. train from St. Pancras, arriving at Luton at 2.25 p.m., and will be met at the station by a representative from the works.

THE ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: MERSEYSIDE BRANCH.—University Engineering Building, Liverpool. "Some Notes on the Design of Overhead Electric Travelling Cranes," by Mr. J. J. Clark. 7.30 p.m.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Radio-activity," Lecture IV., by Sir Ernest Rutherford, F.R.S. 3 p.m.

TUESDAY, MARCH 28TH.

THE ENGINEERS' CLUB.—Manchester. Annual general meeting. 1.45 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY GRADUATES.—At the Broadway Café, Broadgate. Paper, "Road Transport Tires," by Mr. G. M. Martineau. 7.45 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—At the Metropole, Leeds. "Protective Apparatus for Turbo-alternators," by Mr. J. A. Kuyser. 7 p.m. Dinner at 6 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—The College, Loughborough. "The Future Aspect of Power Generation," by Mr. A. H. Seabrook. 6.45 p.m.

THE JUNIOR INSTITUTION OF ENGINEERS: NORTH-EASTERN SECTION.—Armstrong College, Newcastle-on-Tyne. "The Utilisation of Waste Heat," by Mr. G. H. Martin. 7 p.m.

THE INSTITUTE OF MARINE ENGINEERS.—85/88, Minories, E. 1. "Petroleum and Lubrication," by Mr. E. A. Evans. 6.30 p.m.

WEDNESDAY, MARCH 29TH.

THE INDUSTRIAL LEAGUE AND COUNCIL.—Caxton Hall, Westminster, S.W. 1. "The Necessity for Educating the Worker in Industrial Economics," by Major Isidore Salmon, C.B.E. 7.30 p.m.

THURSDAY, MARCH 30TH.

CHADWICK PUBLIC LECTURES.—Gallery of Royal Institute of British Architects, 9, Conduit-street, W. 1. Two lectures on "Water." Lecture II.: "Its Distribution and Use," by Mr. H. E. Stilgoe. 8 p.m.

THE ROYAL AERONAUTICAL SOCIETY.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "Design of a Commercial Aeroplane," by Captain G. de Havilland. 5.30 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Victoria Embankment, W.C. 2. "Applications of Electricity to Agriculture," by Mr. R. Borlase Matthews. 6 p.m.

THE NEWCOMEN SOCIETY.—At the Institute of Marine Engineers, 85/88, Minories, E. 1. "The Centenary of Naval Engineering: A Review of the Early History of Our Steam Navy," by Engineer-Commander E. C. Smith, O.B.E., R.N. 5 p.m.

FRIDAY, MARCH 31ST.

JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, Westminster, S.W. 1. "The Steel Melting Shop," by Mr. D. F. Dickinson. 8 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, S.W. 1. Extra general meeting. "The Milling of Screws, and other Problems in the Theory of Screw Threads," by Professor H. H. Jeffcott. 6 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS: LONDON STUDENTS' SECTION.—Victoria Embankment, W.C. 2. Address by the President (Mr. J. S. Highfield). 7 p.m.